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THE RAILROAD PROBLEM IN THE UNITED STATES.

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GEORGE STEPHENSON, in October, 1829, made his memorable journey in the Rocket over the Rainhill trial course; the next year the Liverpool and Manchester Railway was opened, and soon every civilized nation adopted the new method of locomotion. In the United States a variety of circumstances have concurred to make the railways the most extensive, the most economical in working, and the most influential in the world. The immense area of the country, the small value of most of the land required for the roads, the easy grades marked out by the great water-courses of the continent, and the broad prairie-sweeps, conjoined with the ease and cheapness of obtaining charters, make American railroads but one third as costly in construction as those of Great Britain and the European Continent, and much less expensive in operation. On this side of the Atlantic railways are built with embankments, culverts, bridges, and tunnels, much less elaborate and substantial than those of England and France. The requirement here is not the best but usually the cheapest thing that will serve. This is one of the reasons among others why American freight charges are the lowest in the world. In 1881 the average cost of moving a ton of freight a mile was 1·66 cent in France, 1·5 cent in Belgium, and but 0·9 cent in the United States. The railways of the Union are now 114,000 miles in extent, and construction proceeds at the rate of thirty miles a day. The aggregate capital of the lines is $6,500,000,000, one eighth the valuation of all kinds of property in the country, according to the best estimates.

Less than fifty years ago, within the clear recollection of men now living who were then actively engaged in business, the great problem was, how soon the country could be provided with railroads. Far-

sighted men of capital and public spirit saw something of what railroads were to be, and soon the iron way began to connect the great cities of the Atlantic together, and then these with the interior of the New England and Middle States, until at last the continent has been belted, and the distant mining-camps of the Rocky Mountains, and the broad stretches of the Californian and Texan plains, are directly connected with every city and town in the country. A single life covers the entire period which separates the time when stage-coaching and wagoning were the methods of transportation, from to-day, when railroads loom up in capital and centralized control as the most important element of American commerce.

The benefits derived from the railroads have been so great as to have virtually created the population and wealth of some of the wide Western States and Territories. Railroads have opened up homes for millions sent across the sea from overcrowded Europe, have cheapened food, clothing, and shelter, have practically broken down State and sectional lines, and by interfusion of capital and population have done more to weld the Union together than any other influence. The locomotive has proved a giant indeed, capable of bearing heavy burdens, and accomplishing splendid results; yet of late railroad corporations have shown a disposition to abuse their strength for public oppression, and the railroad problem is, how this tendency may be best overcome.

While on all hands the indebtedness of the community to railroad enterprise is gladly acknowledged, and while the average return on railroad investments throughout the country is but three per cent, and the charges generally are lower than elsewhere in the world, yet the complaints made against some of the leading lines are so serious as to have given rise to one of the angriest discussions of the time.

The chief complaints, of course, have been made against the lucrative roads, those which run through thickly-settled regions, like the New York Central; and against lines which, like the Central Pacific, are monopolies pure and simple. The complaints are of exorbitant charges, of discrimination in favor of individuals, firms, and localities; that the railroad companies lend themselves to the aggrandizement of monopolies such as the Standard Oil Company, and of minor subsidiary organizations, car, bridge, express, stock-yard, and elevating companies which absorb parasitically profits which should belong to the railway shareholders, and which, if rightfully appropriated, would tend to relieve the burdens borne by the general public. The complainants furthermore aver that the railroad companies make use of their influence, as employers of large bodies of voters, to corrupt Legislatures and courts that they may remain unpunished in committing acts of fraud and rapacity, and defeat attempts by the State to exert the control which the highest authorities declare to be within its rightful powers.

To take up these complaints somewhat in detail—and beginning with that of exorbitant charges—there was provision made in most of

the early railroad charters—those of New York State, for instance—whereby the profits divisible annually were limited to ten per cent; but this provision, intended to secure shippers against unduly high rates, has been evaded by the process known as stock-watering. To illustrate: The contract for the consolidation of the lines forming the New York Central Railroad was made in 1853, and the ten amounts of capital then fused formed a total of $23,000,000, on which premiums were granted aggregating $8,900,000. In 1868 and 1869 the New York Central and Hudson River Railroad Companies were consolidated as a single company, which named its capital at nearly $45,000,000 more than the capitals of the two lines before union. Of course, more than ten per cent would have to be earned on the inflated figures before the State law would apply, and by that time doubtless a new company would appear to buy the road at a handsome advance on its nominal capital. The critics of stock-watering or of the capitalizing of surplus earnings say that it is in substance exacting money from the people, creating an indebtedness representing the same, and making this the basis for forever asking the public to pay interest upon their money so exacted. These critics would limit the profits of the lucrative roads, but, unjustly it would seem, would leave the struggling lines to their fate.

The railroad companies are told, "You may earn as little as you can, but, if by good fortune and good management you earn more than ten per cent, the State will seize the surplus." Practically, however, the law can not be enforced, as the common rights of sale and purchase can be exercised to evade it.

In response to the complaints against the New York roads, the Assembly in February, 1879, appointed a special committee, with Mr. A. B. Hepburn as chairman, to investigate alleged abuses, propose remedies, and report. The testimony before this committee fully established the truth of the alleged abuses in discrimination. Mr. Goodman, Assistant General Freight Agent of the New York Central Railroad Company, testified that special rates were given to all points almost invariably when asked. About ninety per cent of the business between New York and Syracuse was done at reductions from tariff terms, and about one half the business between New York and other points was done at special rates. Other witnesses proved that flour had been carried from Milwaukee to New York while the tariff rate was thirty-six cents, at the specially reduced price of twenty cents, the maintained rate at the time from Rochester being thirty cents. Rochester is 350 miles from New York, and Milwaukee 1,030 miles. So marked and inconsistent a difference did there exist between local and through freight charges, that Mr. W. W. Mack, of Rochester, could ship edge-tools to New York and thence to Cincinnati *via* Rochester, and save fourteen cents per hundred; to St. Louis by the same route, eighteen cents per hundred—in each case the goods being

carried seven hundred miles more than a direct haul! Surely one would say that rates devised so loosely as to render Mr. Mack's plan worth adopting discredit the officials responsible for them. Among the remarkable cases of discrimination proved were the following: Babbitt & Co., soap-manufacturers in New York, ascertained that Crouse & Co., of Syracuse, had a special rate of eight cents per box over the New York Central road; Babbitt & Co. asked for a similar reduction, which was refused, the rate charged them being twelve cents to Syracuse, and this while their shipments over the New York Central and Hudson River Railroads aggregated 1,346 tons in the year preceding the session of the committee. In the winter of 1877 Jesse Hoyt & Co. and David Dows & Co., of New York, two large grain firms, controlled the market by having obtained freights from the West two and a half to five cents per hundred less than any of their competitors. Their facilities for freight exceeded their purchasing power, so they actually sublet their privileges to other houses in the trade.

Towering far above all the wrongs under the head of discriminations ever perpetrated by railroads must be placed those committed in favor of the Standard Oil Company. This monopoly, the strongest of the kind in the world, controls the production of petroleum in the United States, the second largest export of the country; its relations with the railroads are such that it obtains freighting at an immense reduction from the terms charged to other customers of the roads. In August, 1879, the Erie and New York Central roads charged the Standard Company about ten cents for hauling a barrel of three hundred and ninety pounds somewhat more than four hundred miles, empty cars having to be hauled back over the lines. Contrast this with the charge of forty-five cents for bringing a can of ten gallons of milk weighing ninety pounds but sixty miles! The proportions are as 1 to 130. From January to October, 1879, the total shipments from the oil-regions were 12,900,240 barrels. All shipments to the seaboard might have borne one dollar more per barrel than they did, yet all these millions of dollars were lost to the roads by a policy for which their officers are accountable. The Central Pacific Railroad Company is another against which discriminations of an unwarrantable character have been proved. While one shipper was charged 65 cents from Ogden to Toano, another shipper was charged $3.35 for the same service. Vegetables were carried for different firms at rates as various as 55 cents and $1.36. Through rates from New York to San Francisco were to some shippers one half those charged to others. The complainants take good ground when they declare that discriminations in favor of particular localities and firms create deficiencies which shippers generally are taxed to equalize; and, as mercantile competition becomes yearly more severe, the unjust discriminations of railroads unfairly discount the legitimate returns of business enter-

prise, and hasten the undesirable tendency so plainly observable on all sides, whereby the great houses are constantly absorbing the trade of the lesser ones, and the business of the country seems passing into fewer and fewer hands.

As to the growth of subordinate railroad organizations, the quotations of the stock-exchanges and the testimony of those interested in investments not listed on the stock-exchanges prove the great lucrativeness of express, fast-freight line, palace-car, elevating, and stock-yard companies. It is a question whether these businesses can be successfully carried on by railroad companies, but, if not, the corporations which give them birth should, if honestly managed, see to it that they retain such interest as to participate in the large profits earned. The chief danger attending these subsidiary organizations is, that the railroad officials who take stock in them are interested in granting them special privileges and good bargains. It is notorious that officers of unprofitable or bankrupt roads have grown rich by interests of the kind mentioned.

The political power which the railroads can exert has repeatedly attracted public attention. In New York State there are thirty thousand railway employés, and the number of people indirectly interested in the roads, and influenced by them, is perhaps equally large. At the capital this voting element has opposed railway legislation, and triumphantly. Parallel cases have occurred in other States, notably in California and Illinois. As an example of what a railroad can do in the way of controlling political action, let this quotation be given from Jay Gould's testimony before the State Committee appointed in 1873 to investigate the management of the Erie Railway: "I do not know how much I paid toward helping friendly men. We had four States to look after, and we had to suit our politics to circumstances. In a Democratic district I was a Democrat, in a Republican district I was a Republican, and in doubtful districts I was doubtful; but in every district, and at all times, I have always been an Erie man." Other testimony proved that millions of dollars had been expended from the treasury of the Erie road in nominating, electing, and corrupting Senators and members of Assembly. A new danger certainly threatens public liberties in the light of these and many kindred revelations, a danger which, perhaps, only counter-organization by the people can successfully face. It was a notable day in American history when the attorney of the Pennsylvania Railroad threatened the Supreme Court of the State with the displeasure of his clients if a verdict unfavorable to them were granted. When President Vanderbilt, of the New York Central, was told about the State Commissioners who were to supervise railroad affairs, he said that either the railroads would have to own the commissioners or the commissioners the railroads. His later utterances with respect to public criticism are tolerably familiar, and need not be here repeated.

The complaints against railroad management, as far as they appear to be just, show that the railroad problem may be divided into two parts: First, how shareholders in railroads can meet the difficulties of joint-stock ownership, and control their property, so that it can be made by all legitimate methods as profitable as possible. This means the election of directors not as now, as a whole board by a single majority vote, but by a plan of minority representation, which will give a voice in the directorate to every interest entitled to it. It means including in the business such branches of traffic as are now delegated to subsidiary companies, where this can be done advantageously; and the employing of officers of such high character and ability that they shall be disposed to co-operate with one another to avoid illegitimate and ruinous competition—officers able to establish tariffs based on sound and consistent principles, and tariffs with which no subordinate officer shall have power to tamper.

The second part of the railroad problem is how the general public, while desirous of paying just remuneration to the roads, may protect themselves against extortion and unjust and arbitrary discriminations. This part of the subject raises the question of the constitutionality and feasibility of State control, and brings up for discussion the various influences which are spontaneously exerted within the railroad business itself for its fair and equitable management. In the brief sketch here presented of the chief complaints made against the railroads, it has been evident that some of the most serious of these complaints arise from the inherent difficulties of joint-stock ownership. A board of directors, provided with many proxies, can do pretty much as they please, and the history of American roads shows that at times they please to enrich themselves at the expense of those whom they represent.

The shareholders in a large company are often a shifting, chaotic, and helpless body, fortunate, indeed, when the directorate are sufficiently honest and interested to administer affairs as they should. It seems strange, too, that the management of railroads should so widely permit an evil which causes so much just censure, namely, the cutting of rates, by a staff of agents scattered throughout the whole country. When control by the owners of railroad property remains as imperfect as it is in important particulars, it certainly seems an idle task to attempt the State control of the largest and most complicated business in existence.

The discussion of the railroad problem has given the public some insight into the difficulties which beset this business. There are now in the United States some twelve hundred railroad companies, more or less actively competing with one another. Between two great cities like New York and Chicago, and between a great center of distribution like St. Louis and the Atlantic seaboard, there are many competing routes, and the contest for business among these routes is

very keen, and at times so violent as to set all considerations of profit at defiance. The routes connecting the great West with the Atlantic ports vary in directness, in gradients, and in the thickness of the population in the districts through which they run; it follows that their inequality of desirableness as freight lines must be balanced by differences in rates. To establish and maintain these differences in rates, it has been the practice for the roads to enter into agreements with one another, and, in making these agreements on fair and satisfactory terms, and in enforcing the agreements when made, have been encountered the most perplexing tasks of railway management. In arguing for a basis of rates, two widely different stand-points are occupied by the trunk-lines running eastward from Chicago. The great interests centering in New York declare that the cost of service should be the prevailing consideration in proportioning rates among competing lines.

It is adduced that the easy gradients of the New York Central and the immense traffic which belongs to the cities and towns through which it runs enable it to be operated at less cost per ton per mile than any other road in the country: the geographical and census arguments should, therefore, be permitted to give New York a preference over competing cities in the framing of joint tariffs. Philadelphia and Baltimore take different ground: they point out that they are respectively one hundred and thirty-two and one hundred and fifty-two miles nearer Chicago than is New York *via* the New York Central, and therefore they desire freight rates to be fixed on the basis of mileage. Contests, which have consumed many millions of dollars, leave the question open as to which of these two principles shall govern the charges of the trunk-lines on through business. Another reason for the difficulty attending the making and keeping of agreements between railroads is the fact that the temptation to bad faith is extreme. If one road can defraud another of some freight by an illegitimate reduction of rate, the cash so earned is almost wholly profit, for the fixed expenses of the road are scarcely affected whether that freight be carried by it or not. The bad faith of a single road can lead to the breach of an agreement entered into by several great roads; and often it is the weak or bankrupt line whose dishonorable dealing leads to a war of rates being declared which may cost a million dollars before it ends. And a curious point comes up just here: so dear to the heart of the average shipper are these wars of rates, that clear-headed men who know his inner springs aver that the shipper does not desire permanent peace among the railroads, and does not wish to see them earn their incomes with the steady regularity enjoyed by the investor, say, in Government bonds. Peace to the shipper would be as distasteful as the absence of fluctuations to the speculator in stocks or grain, for railroad men and those who find fault with them seem to be made of the same clay.

Railroads have enemies within as well as without. Intense competition has given birth to a class of soliciting freight agents, to whom reference has already been made; these men are empowered to grant reduced rates at discretion; their bargains are binding on all the lines forming the routes for which they solicit business, and their acts are in their nature so difficult of detection, and so inimical to the integrity of agreements, that a sound business policy would dictate that their powers should only be wielded by officers of the roads sufficiently high in position and character to guarantee good faith in carrying out the joint contracts made by the presidents of the lines.

It is a strange fact in railroad history that the contracts between roads for the maintenance of rates have never, up to the present time, invoked legal sanction and enforcement; they have been made and broken purely at will. Good authorities, among whom may be named the Railroad Commissioners of Massachusetts, state that the existing laws of the country afford all the provisions needed for the purpose; while, again, the chief railroad expert in the country, Mr. Fink, holds that special legislation is necessary. So important does Mr. Fink hold this matter to be, that he states that when the necessary enactments have been passed, and when railroad managers have the good sense to co-operate and avail themselves of legal authority, he will regard the railroad problem solved as far as solution is possible.

In March, 1882, a commission at Washington, appointed to consider the railway question, brought together Mr. Fink and General Reagan, of Texas, the member of Congress who proposed a bill for the direct regulation of the railroads by the Federal Government. General Reagan's bill is chiefly aimed at what he and many others conceive to be a grave injustice, namely, the discrimination which makes through freight pay a much less rate than local freight, and which grants one shipper more favorable terms than another for the same service. The bill would make the rate per mile uniform over all roads, and would make through rates the sum of the local rates charged over the component parts of a line. The testimony of Mr. Fink before the commission, and particularly in reply to General Reagan, is one of the most instructive pieces of railway literature so far given to the public. Mr. Fink deemed the railroad problem too difficult to be handled by a directly appointed commission: all that he could recommend was a commission to investigate complaints. He pointed out the great services railroads had done the country, and declared the evils attending the management of the business to be largely unavoidable amid affairs so vast and involved. As an example of the benefits railroads had conferred upon the public, he stated that in the fall of 1880 the rate from Chicago to the East was but six tenths of one cent per ton per mile, or equal to carrying seventeen barrels of flour one mile for one cent! The intense competition between roads has been one of the main causes of the remarkable economy of their

management, and their eagerness to adopt every improvement as soon as produced, chief among which improvements must rank the steel rail. Quoting from Mr. Edward Atkinson, Mr. Fink said that an artisan in the Eastern States pays the transportation from Chicago on a year's food by a single day's labor, and so great have been the reductions during recent years, in railway charges, that, had the rates of 1873 been maintained until 1879, the roads would have had in the interval $922,000,000 more revenue than they actually collected. In 1880 more than three times as much freight was carried by the roads as in 1868, and at sixty per cent less rate; and, although shippers may grudge certain companies the appreciation of their property which has taken place—an advance in value decidedly less than that which has overtaken real-estate holdings generally—no agitation has yet been promoted to pay dividends or make up deficiencies on unprofitable lines, although such lines have been indirectly great sources of prosperity to their districts and the country at large. Mr. Fink recognizes the injustice of charging different prices to different firms for the same service, but has no faith in any attempted legal preventives of the practice. Rebates may be granted a year or two after a transaction, or may take the form of gifts, or in other ways detection may be evaded. His explanation of the disparity so often complained of, between local and through rates, is very interesting. A line is built chiefly to accommodate and develop the region through which it passes; that region, without it, might remain backwoods or unbroken prairie; and, therefore, as the services of the road are of most value to its own district, that district should in justice principally contribute to its support. Now, when a road has a fair local business at regular tariff rates, and can add to its business without proportionate increase of expense by taking through freight originating in a city like Chicago, where many competing roads center, then it is allowable to grant marked reductions in terms to attract a share of through business. It is plainly unfair, under the circumstances, to take the stand of certain complainants and ask that local rates be based upon through rates. Mr. Stanford, President of the Central Pacific Railroad, explains some of the discriminations of his line on the same principle. A car-load is taken from New York to San Francisco for $300, but if dropped at Elcho, 619 miles east of San Francisco, the charge is $800, the sum of the through rate from New York to San Francisco, plus the charge from San Francisco to Elcho. Mr. Stanford points out that his road has to meet severe water competition at San Francisco, and that therefore the local rates charged towns created by the line can have no relation to competitive terms, and must wholly rest on considerations of the revenue to be earned on the capital employed, after the expenses of management are paid. Facts worthy of being weighed in this connection are that cars carrying local freights are, on an average, not more than a quarter filled, and that they are subject

to long delays at way-stations, causes justifying low rates on full cars in active motion on long, unbroken journeys.

Another form of allowable discrimination Mr. Fink holds to arise where a new industry awaits development, and offers all it can afford to pay—a rate somewhat under the tariff. He gives as an example a case where staves from a Western point were to be sent to England, to compete there with staves from Norway: he holds it to have been good railway policy to create freight by carrying it at a reduced figure, if it gave promise of increased business in the future, with a prospect of building up a new industry for the country.

The Anti-Monopoly League of New York, an association formed to expose railroad abuses, and to endeavor to have them corrected by political agitation and legislative enactment, has widely circulated as the policy of the Erie and New York Central Railroads a statement signed by their presidents, wherein they declare it their principle to charge all an article will bear, and at the same time stimulate its production (they probably meant, not interfere with its production). On the Central Pacific Railroad the value of a shipment of ore or merchandise affects the cost of its carriage, and at first view the fact certainly has an arbitrary look. The explanation of the somewhat carelessly stated principle is this: Ores of various values are offered to the Central Pacific road, let us say; the least valuable can not afford to pay tariff rates, although it can pay the cost of transportation and a small percentage of return to the capital of the line. The manager decides that a little profit is better than none, and accepts the ore of small value at a reduced rate. The same principle of classification makes dry-goods pay a higher rate than coals, just as letters cost more for postage than books and parcels; its adoption develops the utmost quantity of railroad business, cheapening the average charge, and adjusting the burden of expense to the various capabilities of the different elements of traffic. Railroad managers, on the same general principle, find it pays to develop suburban passenger and excursion business on terms much below the charges for single tickets.

Against the proposal of General Reagan and others to make a uniform rate for every mile of railroad in the country, it is very properly urged that tariffs must vary from many considerations: the indirectness of one road competing with a shorter one obliging it to charge a lower rate per mile, or do no business; the determination of freight in a single direction, as of lumber from the Wisconsin forests, which requires the hauling of empty cars northwestward; the comparatively small business of some lines such as those common in the West, which serve as mere gatherers-up for the trunk-lines and feeders of them; the cost of fuel, three times as much in some parts of the country as in others, and, at the cheapest, a main element of railroad expense; difficulties of grade, which may make a single mile more costly in maintenance and operation than ten miles of level track; contingencies of

climate, which in northern latitudes may wholly suspend traffic at times or make train service in an extraordinary degree both expensive and hazardous ; the enormous cost of bridges and tunnels, and the terminal facilities of great cities—all fairly weigh as causes for varying assessments of tariff. Surely such considerations as these must set aside any attempt at the solution of railroad difficulties by the arbitrary rule of a uniform rate—uniform only in name, for genuine uniformity of charge can only be worked out by a broad view of the whole business of railroading in its full extent and detail, a view which it would be folly to expect a State Assembly or a State Board to take.

The trunk-lines connecting the West with the Atlantic have a Joint Executive Commission at New York, for the establishment and maintenance of rates. Though suffering from the merely voluntary nature of its constitution, and without the power of legally enforcing its agreements, the commission gets along pretty well, mainly through the esteem in which are held the character and ability of its chief commissioner, Mr. Fink. He gives a clear explanation of how co-operation, federation, or what is commonly called "pooling," may solve the problem of fixing rates and making railroads keep to them. Pooling may be explained, to readers unfamiliar with the term, as the gathering into a common fund of all the receipts of a group of railroads (or other corporations), for division according to a prearranged scale of apportionment. Mr. Fink points out that in peace or war the proportions of freight carried by the different through lines remain substantially invariable. He dwells on the powerful motives acting within the railroad business itself to prevent exorbitant charges. Traffic would not grow unless fairly treated, and the efforts of railroad managers have plainly been to reduce rates whenever possible to do so. The pool of which Mr. Fink is chief commissioner has gradually reduced its charges until they have fallen below those of the Erie Canal. The Southwestern pool has constantly reduced its tariff, seeing in that policy the best means for increasing its business and the net profits of its roads. Water competition has a far-reaching effect in railroad tariff, as an illustration will show: A reduction in rates between Chicago and New York, to meet lake and canal tariffs, creates reductions at Louisville, Nashville, and Savannah, for these cities have also their competing routes to New York. All rail routes from Chicago to so interior a point as Atlanta must conform to the total rate made up of the charges from Chicago to New York, from New York to Savannah by sea, and from Savannah to Atlanta by rail. Mr. Fink shows that competition within the pool is powerful to prevent excessive charges—thus the roads running from Indianapolis eastward must meet Chicago competition, otherwise shippers would send their freights to Chicago to go East, and the Indianapolis roads would remain idle. The bitterest complaint against railroads, that of discriminations in favor of individuals and special firms, finds its removal in

the pool-system, for, with a fixed percentage of the total earnings of a federation of roads, what temptation can remain to make one particular road do more business than that agreed upon as its share? To the objection that pooling would abolish the incentive to excellence in each road, Mr. Fink answers that the system provides for a periodical reapportionment of percentages of earnings among the lines, and that at such times the public preferences for prompt and well-managed lines would tell, to the punishment of dilatory and badly conducted roads. One of the unavoidable difficulties of pooling must ever be the decision as to the percentage allowable to a new line. Only costly trials of strength seem to be able to bring about such decision.

The prices of various important commodities in the different markets of the Union limit the freights chargeable upon them. Thus, if Liverpool salt is to compete with the American article, its carriage inland must be very cheap; and wider considerations of the same kind have to be borne in mind by those intrusted with the power of making tariffs over the great lines. American grain competes with Russian in the great market of Liverpool, and a question of the tenth of one cent per ton per mile may in the long stretches of American rail-carriage decide for or against the sale of the Iowa or Minnesota farmer's produce. The tea and silk trade of China with Great Britain can choose between two great routes, the direct water-route, or the journey in part made up of the American transcontinental railroads.

A closing argument on behalf of pools remains to be stated. They make each great road the guardian of its district, which would not be the case were there to be a consolidated monopoly instead of a pool. As matters now stand, the Pennsylvania and the Baltimore and Ohio roads prevent a concentration of business on the New York Central, the line on which, as far as simple and direct economy is concerned, the harvests of the West can be cheapest carried to the seaboard. Pools, too, by preventing wars, will tend to make railroading less uncertain and more profitable than it has been, and will thus lead to new lines being constantly built.

The detailed criticism of General Reagan's proposed enactments presents fatal objections, and furnishes a new theme for that school of thinkers who hold that the sphere of legislation does not include the control of any business whatever, which may be safely left to meet its difficulties spontaneously. General Reagan's uniform mileage rate would give the shortest route connecting New York and Chicago the lowest rate; hence that route would command all the business until it could accept no more, when the next shortest would come in for the surplus, and so on, leaving nothing for indirect routes whatever. Besides, in railroad practice after the Chicago rate eastward has been fixed, the St. Louis business comes in, and the competition of the roads directly connecting St. Louis and the Atlantic ports must be met by the routes less directly connecting the termini *via* Chicago. As a

matter of fact, the shortest or economically best line fixes the rate, and other lines must base their charges thereupon.

Should there be formed in America a general pool to establish tariffs as the Railway Clearing-House does in England, or the Railway Unions do in Germany, it would probably enter into relations with the Federal Government for the sanction and enforcement of its contracts.

The strong pleas made by the railroad interest do not silence the voice of murmuring. Every great railroad serves without competition important breadths of country, and proofs abound that the interest of a road may not always be a consenting parallel with the interests of its patrons. Charges much higher than justice would fix are exacted from customers, who must submit, and who are not sufficiently injured to be driven from their field. There is something ominous, too, in the way in which coarse and unscrupulous men are getting more and more control of the railroad system of the country. People are asking, "What is to prevent the great railroad presidents from exercising their power arbitrarily, and compassing the ruin of individuals, firms, and localities?" Some of the eminent statesmen and politicians of the republic are of firm belief that the railroads are getting too much power, and that the abuses complained of here and there now are only examples of what may be expected very generally as the years of the near future elapse. The lurid light of "Standard" oil shows how a railroad oligarchy might repeat abuses of its power in the dishonest control of great staples which, like petroleum, form the bases of national wealth. A rise or fall of five cents a bushel in the freight from Chicago to the seaboard affects the value of every farm in the West, and it is easy to see how speculative interests can unwarrantably depress prices for a time so as to enrich the few manipulators of the market.

There is throughout the Union great capacity on the part of the people to organize for political ends, and, when the agitation against the railroads took place in the West a few years ago, the rapid spread of the Granger movement showed the power the public are ready to exert whenever they feel that they suffer grievances capable of remedy, and this dormant force in the last resort will rise to resist any tyranny which railway kings may be foolish enough to exercise. Among the most prominent public men who are of opinion that it is now time that the Federal arm were invoked to repress railroad aggression and who advance the cause of anti-monopoly, may be named Senators David Davis and William Windom, Judge Jeremiah S. Black, and Governor Gray, of Indiana. Judge Black holds the paradoxical opinion that railroads are held by their owners simply as trusts, and that therefore their tariffs should be public, reasonable, and just. Hon. J. M. Mason, of West Virginia, holds that railroads are common carriers who levy tolls and exercise eminent domain, and as such they

are subject to government control for the enforcement of reasonable rates. Chief-Justice Waite has decided that a State has the right to regulate any business such as grain-elevating, dedicated to a public use, and this decision is held to apply *a fortiori* to railroads. All authorities agree that each State can, if it chooses, supervise the railroads within its borders in the public interest, and the allowability of Federal control is deduced from that paragraph in the Constitution which says that Congress has power to regulate commerce between the States. Against all this the railroads urge that the essence of property is in control, and that if the Government wishes to manage the lines it should buy them. It is contended that no Government officials can fitly prescribe rules for the regulation of a business so complicated as railroading, and that complaints so far from being abated would increase were the blight of political patronage to fall upon the transportation lines of the country. The party who urge the necessity of Government control of railroads among their arguments give prominence to the fact that an area of public lands, nine times that of Ohio, has been given to railroads to aid in their construction. In reply, the corporations say that these lands formed part of the business consideration on which they began work; and, furthermore, the value of these lands for the most part has been created solely by the existence of railroad facilities.

The debate for and against leaving the railroad problem to solve itself has not shown that the people who wish to invoke control by the Federal Government have numbers or influence or very sound arguments on their side. To throw the management of between six and seven thousand millions of capital into the hands of political partisans, who only represent the people in an indirect way through cumbrous elective machinery, is a proposal which few seriously consider; but, if the Federal Government can not honestly and safely be called upon to control railroads, the establishment of railroad commissions may render important services to the public. Twenty-six of the States have such commissions, intended to supervise and regulate railroads in the public interest, but the variety in the laws creating them, the limits of State jurisdiction in the presence of so many interstate roads, and their general lack of authority, render their efforts but feeble. These commissions depend for success on the degree of good sense which is employed in forming them, in the personal character and ability of their boards, and in the commissioners remaining long enough in office to be able to gain and use experience in their duties. Of the commissions so far established in the Union, that of Massachusetts takes the lead; its guiding principle is not that of force, so popular in Western railroad legislation, but that of publicity, trusting to the influence of an enlightened public opinion. The Massachusetts Commission has authority to obtain and publish in full detail the annual statements of the railroads of the Commonwealth. Their capitals,

earnings, expenses, and profits, are all clearly tabulated, as the book-keeping of all the companies is on a uniform and simple plan. The tariffs of the roads are accessible to the commission, which is a bureau where complaints of unjust discrimination can be lodged for inquiry and for correction, as far as its powers admit. These powers the commission believes might be advantageously extended, for the abstract rights of the public without legal remedies are very apt to be disregarded. The authority of the board, however, extends to enforcing for public safety the proper strength, breadth, and height of bridges and tunnels, and such guarding of crossings and employment of mechanical appliances as experience suggests for adoption. All serious and fatal accidents are investigated, and the "Annual Report" of the board is a document which might serve as a model of a business-like State paper.

A system of State commissioners patterned after the Massachusetts board, with a national center of reference, is as much in the way of legislation and public supervision as the leading railroad minds of the country deem advisable at present. The chiefs of the greatest commercial interest of America are quite prepared to accept legislation; all that they ask is that it be intelligent.

The public must not, however, expect too much from enactment, for, with business morality as it is, why should ideal justice prevail in railroad transactions more than in any other? The fact which on the broad stage of railroading is odious discrimination, less recognizably pervades the smaller circles of trade where employés permit personal interest or personal friendship to jolt the sacred scales. The view that railroading is a special and public service, in a sense which entitles the people to control it, is not a view which the facts of American politics favor as yielding any practical suggestion.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

DYSPEPSIA.

BEFORE our ancestors colonized the colder latitudes of this planet, the equatorial regions had for ages been inhabited by men or man-like four-handers. The influence of this long abode in the tropics still asserts itself in many peculiarities of our physical constitution. We are but half acclimatized. Wolves are weather-proof; bears and badgers have managed to inure themselves to the miasma of their winter dens: but the primates of the animal kingdom can neither endure cold nor breathe impure air with perfect impunity; and of most of our civilized fellow-men, as well as of savages and all the species of our

four-handed relatives who have thus far been wintered in northern menageries, it may be said that the sensitiveness of their lungs contrasts strangely with the tough vigor of their digestive organs.

In proportion to his size, a rhesus baboon eats more than a wolf; between morning and night a ceboo monkey will devour his own weight in bananas, and, where the cravings of a naturally vigorous stomach are increased by the stimulus of a cold climate, it seems almost impossible to surfeit a savage with palatable food; his appetite is the faithful exponent of his peptic capacity, and before the fauces positively refuse to ingest there is little danger that the gastric apparatus will fail to digest. Manifold and enormous must have been our sins against the dietary code of Nature before we could succeed in making indigestion a chronic disease. Deviations from the chemical standards of her *menu* are insufficient to account for her wrath. With all their unmistakable structural evidences of a frugivorous purpose, our digestive organs have been permitted to adapt themselves, not only to a carnivorous and herbivorous diet and various innutritive substances, but to a considerable number of positive poisons. The Yakoots live on fish and seal-blubber. The Shoshones stick to bull-beef. The Namaqua Hottentots (who can not plead the exigencies of a cold climate) subsist almost entirely on venison. Several tribes of Northern Brazil eat clay with comparative impunity. Our Saxon forefathers added beer to venison and beef, and when they took to in-door life the stomach protested only by proxy; 'an utterly wrong diet led, not to dyspepsia, but to scrofulous affections. Excess in moderately unwholesome viands has to be carried to a monstrous degree before the after-dinner torpor turns into a malignant disease; the stomach of a nomad seems to acquire a knack of assimilating a modicum of the ingesta and voiding the rest like so much innutritious stuff. Dr. Robert Moffat saw a Bushman eat twenty pounds of hippopotamus-liver and a bucketful of broiled marrow, besides handfuls of ground-nuts, parched corn, and hackberries—all within twenty-four hours. In the provincial capitals of Northern China, where banquets of forty courses are *de rigueur*, convivial mandarins learn to devour a quantum of comestibles that would torpify a boa-constrictor. Eating-matches of fourteen and fifteen hours did not prevent Vitellius from acquiring distinction as a wrestler.

Daily alcohol-fevers, combined with pepper and mustard inflammations, would ruin the stomach of an ostrich; but in favor of the unfeathered biped Nature accepts such vicarious atonements as gout and dropsy. Thousands of crapulous Bavarian beer-swillers, who are hardly able to walk, are still able to digest their food. In-door life and want of exercise then added their quota of provocatives; but, where the lungs would have rebelled after seven protests, the stomach forgave seventy-seven times. Mediæval prelates, squires, and aldermen tried in vain to exhaust the patience of the long-suffering organ.

But their descendants finally solved that problem. To the alcoholic stimulants of the ancients we have added tea, coffee, tobacco, absinthe, chloral, opium, and pungent spices. Every year increases the number of our elaborately unwholesome-made dishes, and decreases our devotion to the field-sports that helped our forefathers to digest their boar-steaks. We have no time to masticate our food ; we bolt it, and grumble if we can not bolt it smoking hot. The competition of our domestic and public kitchens tempts us to eat three full meals a day, and two of them at a time when the exigencies of our business-routine leave us no leisure for digestion. At night, when the opportunity for that leisure arrives, we counteract the efforts of the digestive apparatus by hot stove-fires and stifling bedrooms. Since the beginning of the commercial-epicurean age of the nineteenth century the votaries of fashion have persistently vied in compelling their stomachs to dispose of the largest possible amount of the most indigestible food under the least favorable circumstances.

That persistence has at last exhausted the self-regulating resources of our digestive organs. But even after such provocations the stomach does not strike work without repeated warnings. The first omen of the wrath to come is the *morning languor*, the hollow-eyed lassitude which proves that the arduous labor of the assimilative organs has made the night the most fatiguing part of the twenty-four hours. The expression of the face becomes haggard and sallow. The tongue feels gritty, the palate parched, in spite of the restless activity of the salivary glands, which every now and then try to respond to the appeals of the distressed stomach. Gastric acidity betrays itself by many disagreeable symptoms ; loss of appetite, however, marks a later stage of the malady. For years the infinite patience of Nature labors every night to undo the mischief of every day, and before noon the surfeited organs again report ready for duty. Habitual excess in eating and drinking sometimes begets an unnatural appetency that enables the glutton to indulge his *penchant* to the last, only with this difference, that the relish for special kinds of food has changed into a vague craving for *repletion*, just as the fondness for a special stimulant is apt to turn into a chronic poison-hunger. This craving after engorgement forms a distinctive symptom of *plethoric dyspepsia*, but even in the first stage of asthenic or nervous dyspepsia the hankering after food is not hunger proper, but a nervous uneasiness, suggesting the idea that a good meal would, somehow, supply the means of relief. The first full meal, however, entails penalties which the sufferer would gladly exchange for the less positive discomfort of the morning. Instinct fails to keep its promise, as a proof that Nature has been supplanted by a deceptive second-nature. Headache, heart-burn, eructations, humming in the ears, nausea, vertigo, and gastric spasms, make the after-dinner hour "the saddest of the sad twenty-four" : a dull mist of discontent broods over the whole afternoon, and yields only to tea

and lamp-light. The patient begins to fret under the weight of his afflictions, but still declines to remove the cause. To out-door exercise he objects, not on general principles, but on some special plea or other. He has to husband his strength. The raw March wind would turn his cough into a chronic catarrh. The warm weather would spoil his appetite and aggravate his vertigo. The truth is, that of the large quantum of comestibles ingested only a small modicum is *digested*, and that the system begins to weaken under the influence of indirect starvation. Business routine prevents the dyspeptic from changing his meal-times. He can not reduce the number of his meals; people have to conform to the arrangements of their boarding-house. The stomach needs something strengthening between breakfast and supper. The truth is, that the exertions of the digestive organs alternate with occasional reactions, entailing a nervous depression which can be (temporarily) relieved by the stimulus of a fresh engorgement. Business reasons may really prevent a reduction of working hours, and domestic duties a change of climate or of occupation. The daily engorgement in the mean while goes on as before.

Nature then resorts to more emphatic protests. Sleep comes in the form of a dull torpor that would make a nightmare a pleasant change of programme. The digestive laboratory seems to have lost the discretion of its automatic contrivances; the process of assimilation, in all its details, obtrudes itself upon the cognizance of the sensorium, and urges the co-operation of the voluntary muscles. Contortions and pressing manipulations have to force each morsel through the gastric apparatus; the lining of the stomach has become sentient, and shirks its work like a blistered palate. Special tidbits can be traced through the whole course of their abdominal adventures. Undigested green peas roll on like buckshot hot from the smelting-pan of a shot-tower. A grilled partridge crawls along like a reluctant crab, clawing and biting at each step. Nausea and headache strive to relieve themselves in spasmodic eructations. Vertigoes, like fainting-fits, eclipse the eyesight for minutes together. Constipation, often combined with a morbid appetite, suggests distressful speculations on the possible outcome of the accumulating ingesta. The overfed organism is under-nourished to a degree that reveals itself in the rapid emaciation of the patient. The general derangement of the nervous system reacts on the mental faculties, and impairs their efficacy even for the most ordinary business purposes, till the invalid at last realizes the necessity of reform. He tries to reduce the number of his meals; but the lengthened intervals drag as heavily as the toper's time between drinks. He hopes to appease his stomach by a change of diet, but finds that the resolution has come too late; the gastric mutiny has become indiscriminate, and protests as savagely against a Graham biscuit as against a broiled pork sausage. He tries pedestrianism, but finds the remedy worse than the evil. The enemy has cut off his means of retreat; the

necessitous system has no strength to spare for such purposes as an effort of the motive organs. But nine out of ten dyspeptics resort to the drug-store. They get a bottle of "tonic bitters." They try Dr. Quack's "Dyspepsia Elixir." They try a "blue pill"—in the hope of rousing Nature, as it were, to a sense of her proper duty.

Now, what such "tonics" can really do for them is this: they goad the system into the transient and abnormal activity incident to the necessity of expelling a virulent poison. With the accomplishment of that purpose the exertion ceases, and the ensuing exhaustion is worse than the first by just as much as the *poison-fever* has robbed the system of a larger or smaller share of its little remaining strength. The stimulant has wasted the organic energy which it seemed to revive. "But," says the invalid, "if a repetition of the dose can relieve the second reaction, would the result not be preferable to the languor of the unstimulated system? Wouldn't it be the best plan to let me support my strength by sticking to my patent tonic?"

Yes, it would be very convenient, especially in times of scarcity, if a starving horse could be supported by the daily application of a patent spur. It would save both oats and oaths. Even a fastidious nag could not help acknowledging the pungency of the goad. But it so happens that spur-fed horses are somewhat short-lived, though at first the diet certainly seems to act like a charm. For a day or two the drug stimulates the activity of the digestive organs as well as of the mental faculties, but the subsequent prostration is so intolerable that the patient soon chooses the alternative of another poison-fever. Before long the pleasant phase of the febrile process becomes shorter and the reaction more severe; the jaded system is less able to respond to the goad, and, in order to make up for the difference, the dose of the stimulant has to be steadily increased. The invalid becomes a bondsman to the drug-store, and hugs the chain that drags him down to the slavery of a confirmed poison-habit.

Circumstances may differ. A dyspeptic who intends to make his own quietus within a month or two, and in the mean while has a certain amount of work to finish, would be justified in stimulating his working capacities by all means, in order to improve to the utmost whatever chances of mundane activity may remain to him. But he who intends to stay has to make up his mind that recovery can not be hoped for till he has not only discontinued his drug, but expiated the burden of sin which the stimulant outrage has added to the original cause of the disease. Nature has to overcome the effects both of malnutrition and of malpractice. The drug has complicated the disease.

In childhood chronic dyspepsia is nearly always the effect of chronic medication. Indigestion is not an hereditary complaint. A dietetic sin *per excessum*, a quantitative surfeit with sweetmeats and pastry, may derange the digestive process for a few hours or so, but the trouble passes by with the holiday. Lock up the short-cakes, admin-

ister a glass of cold water, and, my life for yours, that on Monday morning the little glutton will be ready to climb the steepest hill in the county. But stuff him with liver-pills, drench him with cough-sirup and paregoric, and in a month or two he will not be able to satisfy the cravings of the inner boy without "assisting Nature" with a patent stimulant.

But is it fair to denounce a palliative when the radical remedies have lost their efficacy? What dietetic reform can avail a man to whom oatmeal-gruel has become a poison? How can he invigorate his system by exercise if he is hardly able to support himself on his legs? The asthenic stage of the disease can reach a degree when the mere suggestion of gymnastic enterprises is enough to produce a fit of nervous spasms. I have known of dyspeptics who would not have crossed a room to save a pet bird from the claws of a cat, and who would have joined an expedition to the north pole as soon as to the skating-ring. Theirs is a sad plight, for a rule that holds good of unnatural habits in general applies more especially to the chronic establishment of dietetic abuses, namely, that the further we have strayed from nature, the longer and wearier will be the road of reform. Before the invalid can restore the health and vigor of his system, he has to restore his *capacity for exercise.* The first object is to create a healthy demand for nourishment. Under normal circumstances that demand is proportioned to the amount of the organic expenditure. The nursing females of the mammalia require a larger amount of nourishing diet than the ordinary wants of the system would account for. During the age of rapid growth, children eat and digest as much as hard-working men. Diabetes, the first stage of consumption and other wasting diseases, is characterized by an exorbitant appetite. Every increase of muscular activity involves an augmented demand for nourishment; *cæteris paribus,* the man who walks a mile from his shop to his home will digest his supper more easily than he who takes the street-car. The hotel-boarder who makes it a rule to walk up the four flights of stairs to his attic will sleep sounder, and awaken more refreshed, than he who uses the elevator.

But the far-gone dyspeptic who is incapable of an active effort has to begin with a passive method of natural stimulation—the REFRIGERATION-CURE, based on the tonic influence of cold air and cold water. Voracity increases with the distance from the equator. An Esquimau eats a quantum that would crapulate three Hottentots and six Hindoos. A cold winter curtails the profits of boarding-houses. Camping in the open air whets the appetite even without the aid of active exercise. A bracing temperature exacts a sort of automatic exercise: it accelerates the circulation, it promotes the oxidation of the blood, and indirectly stimulates the whole respiratory process.* The

* "Why should sickness prevail during the warm, pleasant weather so much more frequently than during the cold? The reason appears to me very plain. The cold weather

generation of animal caloric has to be increased to balance the depression of the external temperature. Hence the invigorating effect of mountain-air, of sea-bathing, and, in high latitudes, of sea-voyages. The first dose of the tonic can be applied in-doors: sponge and shower baths, or Franklin's *air-baths*—a few minutes' pause between undress and bed-time.

People who have got rid of the night-air superstition can almost defy dyspepsia by sleeping in a *cross-draught*, or, in cold weather, at least near a half-open window. Cold, fresh air is an invaluable aid to the assimilation of non-nitrogenous articles of food (fat meat, butter, etc.). Stifling bedrooms almost neutralize the effects of out-door exercise. Winter is, therefore, on the whole, the most auspicious time for beginning a dyspepsia-cure. In summer a highland sanitarium is the best place to start with, or, for coast-dwellers, a surfy sea-shore. Early rising, a cold bath before breakfast, frequent ablutions, deep draughts of cold water, flavored with Seltzer and sugar or a few drops of raspberry-sirup, an air-bath before going to bed, and wide-open bedroom-windows, will score an important point in favor of Nature—the return of a normal appetite, and with it of renewed strength and mental elasticity. If the after-dinner affliction should show no direct signs of abatement, the patient must bide his time, and, under no circumstances, resort to the drug-exorcism. Temporary blue-devils are far preferable to a persistent blue-pill Beelzebub. But aid Nature by all legitimate means. Masticate thoroughly every mouthful of solid food. Eschew spices. Avoid pickles, cheese, salt meat, sour-krout, and hot drinks. Take a light breakfast, a lighter lunch, postpone the principal meal till the day's work is done, and make the after-dinner hour as pleasant as possible. Court fresh air at all times of the day and the night, and, in the course of two or three weeks, the capacity for active exercise will return. That point gained, the problem of recovery is reduced to a question of perseverance. The distress of the first attempts suggests almost the expediency of an unconditional surrender, but, after a dozen morning promenades in the park, and as many dumb-bell *soirées*, the three chief remedies begin to work hand in hand—exercise, refrigeration, and temperance. Exercise spices non-stimulating food, fresh air promotes digestion, and restored digestion gives strength for more exercise.

There will be fluctuations in the progress of convalescence. The valor of it, the confidence in the possibility of complete expiation, will sometimes falter under the realizing sense of past sins. The very effectiveness of the remedies will demonstrate the almost unpardonable mistake of their long neglect. But the stomach is not implacable, and, in spite of a few fretful relapses, it will, on the whole, accept the terms of reconciliation and ratify the treaty from week to week, till

braces us up, gives us a sharp appetite, and we indulge freely in food which, while the cold weather continues, can be tolerated by the system."—(Dr. C. E. Page.)

the convalescent has reached the maximum, and future average, of two hours per day of active OUT-DOOR EXERCISE. Languid promenades may require an extension of that time; wood-chopping will justify its reduction to an hour and a half. For rainy days there should be a covered wood-shed, or, better yet, an amateur carpenter-shop with a liberal supply of dull saws and thick boards. Asthenic invalids will derive great benefit from horseback-exercise, or even from a buckboard trip —with or without catch-ropes—the great desideratum in antibilious exercises being *concussion*, the sound shaking-up of the whole frame. Trapeze-evolutions, spring-board and dumb-bell practice rank, therefore, highest among the gymnastic specifics; wood-cutting and sawing among the more arduous kinds of manual labor; and trotting down-hill among the various modes of pedestrian exercise. It is worth a dyspeptic's while to hire a sedan-chair to lug him to the top of an out-of-the-way hill, and a boy to run him a race to the foot of it. After a week or so he will be able to dispense with the sedan. At the first symptoms of indigestion, book-keepers, entry-clerks, authors, and editors should at once get a *telescope-desk*. Literary occupations need not necessarily involve *sedentary* habits, though, as the alternative of a standing-desk, I should prefer a Turkish writing-tablet and a square yard of carpet-cloth to squat upon. But Schreber's telescope-desk enables the writer to sit and stand by turns, and has the further advantage of a sloping top that eases the wrist by resting the weight of the arm upon the elbow.

COLD-BATHS (always *before* dinner) may be limited to the summer season; but open bedroom-windows are *de rigueur* the year round. As long as the bedclothes keep the couch warm, the lungs can inhale cold air not only with impunity, but with the most unmistakable benefit to the digestive organs. The cold nights of the South African tablelands enable the Caffre to digest his barbecues of sorghum-beer and rhinoceros-steaks, and the neighborhood of a glacier makes many a Swiss highland hotel a stronghold of gluttony. In the dog-days it can do no harm, in a sequestered region, to take a river-side ramble at a time when only the moonlight watches on the meadows, for out-door exercise on an oppressively sultry day may defeat its object and bring on a fit of retching and nausea. Intensely cold air, on the other hand, is such a powerful tonic that, in midwinter, a ten minutes' trot along an icy pavement will often serve all the digestive purposes of that day, though the convalescent will be surer to have fulfilled all righteousness by adding half an hour's arm-work in the wood-shed. In midsummer dyspeptics sometimes deprecate exercise on the peculiar plea that a long-continued muscular effort acts as a reliable *astringent*, and the testimony of a veteran gymnasium-teacher of my acquaintance seems to confirm the physiological fact. But, in the first place, a transient constipation is no very serious matter, and, besides, the danger can generally be obviated by training early in the morn-

ing, or (about three hours after the last meal) in the cool of the evening.

Dietetic reforms should begin with the prescription of a strictly non-stimulating diet. A spoonful of mustard, a glass of small-beer or claret, may seem a mere trifle; but the trouble is that all stimulant-habits are progressive: the pungent spices are apt to slide into pungent tobacco, and the claret into port, or something worse. Fresh apple-vinegar, with a fruity flavor, can perhaps not do much more harm than sweet cider, but salt is not quite above suspicion, and the safest plan is to stick to comestibles that can be eaten without it. Cream, for that and other reasons, is better than fat meat, a whortleberry-soup better than a gravy-soup, and a raspberry-pudding preferable to a blood-pudding. All fried and broiled viands, all pickles, all rancid cheese, butter, and sausages, all smoked meats, are suspicious. Catchup-vials harbor the bottled-up demon of indigestion. But, withal, the diet should not be insipid. Ultra-vegetarians denounce all kinds of fat. Ultra-Grahamites suspect all sorts of sweetmeats. "Let your cook distinctly understand," says one peptic philosopher, "that, on peril of her life, she is to set nothing savory before you." Many hygienic institutes feed their dyspeptics on stale bran-bread, water-gruel, and watery vegetables. Man has a right to decline existence on such terms. Not the naturally palatable, but the unnaturally stimulating, qualities of a dish tempt the dyspeptic to eat to excess. For one man who surfeits himself with sweet grapes or pancakes, a thousand, at least, derange their digestion with strong cheese, or hot-peppered ragoûts. Alcoholic stimulants kill hundreds every year; how many intemperate drinkers have ever killed themselves with fresh milk or lemonade? And can not fruits, flour, milk, eggs, sugar, and orange-juice, furnish the ingredients of a very tolerable meal?—not to mention berries, tubers, and dozens of harmless vegetables that can be creamed and sugared into tidbits to rival the *entrées* of the Frères Provençaux in everything except virulence, *alias* pungency. It is better to improve the digestion than to spoil the appetite, for no man can thrive on a naturally distasteful diet. Nature intended us to be *vegetarians;* but I can not help thinking that the word is misleading by its popular association with the idea of kitchen-vegetables. Our next relatives in the animal kingdom do not live on pot-herbs, but on fruit. The victims of *plethoric dyspepsia*, the chronic gluttons who gorge for the sake of repletion, would stuff themselves with a potful of watery spinach as quick as with an eel-pie; and theirs is a rare, but indeed rather embarrassing predicament: they seem as unable to stop eating as to begin digesting. They are evermore esurient, though as cachectic as a starved Silesian weaver; I have seen gouty gluttons, to whom the sight of a restaurant-window was as tempting as a tavern-sign to a toper. Certain drugs would abridge their *penchant*, but, with it, also, the last traces of a digestive function; and, instead of reduc-

ing their appetite, it is better to reduce its capacity for mischief, by limiting the number of their daily meals. For, after all, that capacity is circumscribed by the caliber of the stomach, and, if the quality of the food is unexceptionable, there is no serious danger of a man's eating more at *one* meal than his system, under otherwise favorable circumstances, can dispose of in the course of the next twenty-three hours. The apprehension in *such* cases as to the insufficiency of one meal a day is wholly gratuitous. For more than a thousand years the one-meal system was the rule in two countries that could raise armies of men every one of whom would have made his fortune as a modern athlete—men who marched for days under a load of iron (besides clothes and provisions) that would stagger a modern porter. Even here, abstinence is easier than temperance; for twenty-three hours of each day it is far easier to abstain from food (though, of course, not from water) than to begin eating and stop in time. Not one glutton in a thousand will do it. Dio Lewis recommends a limited number of dishes—"never put more on the table than you intend to eat"; but the first mouthful reawakens the passion of Polyphemus, and for those who can not govern their appetite it is just about as easy to call for another dish as to reach for another plateful. But it is an excellent rule to *prolong the pauses* between the several dishes of a full meal, in order to give the stomach time to indicate the real wants of the system. "The ingestion of food," says Dr. Carpenter, "can not *at once* produce the effect of diminishing the feeling of hunger, though it will do so after a short time, so that, if we eat with undue rapidity, we may continue swallowing food long after we have taken as much as the wants of the body require."

The origin of the glutton-habit can often be traced to the mistaken liberality of a host who constantly urges the conviviality of his young guests, or even to the fatuous tenderness of nursing mothers, who so frequently think it their duty, as Dr. Page expresses it, to make a baby "guzzle till it is ready to die with fatty degeneration."

Begin with reducing the number of daily meals, and exercise, a change of climate and of habits will by-and-by help to subdue the baneful *penchant*. Occasional relapses can not be avoided; but the progressive relief from a number of the worst gastric afflictions will at last induce the veriest cormorant to stick to the one-meal plan.

The best time for that one meal is the end of the working-day—4 or 5 P. M.—when business-cares can be laid aside for the rest of the evening. Asthenic dyspeptics, too—all, at least, who are not completely masters of their own time—had better choose that hour for their principal meal. No other hygienic mistake, not even the stimulant-fallacy, has done so much to make ours a dyspeptic generation as the fatal habit of *after-dinner head-work*—severe mental labor in the study, the school-room, or the counting-house, at a time when the whole strength of the system is claimed by the digestion of a heavy

meal. Not only that the progress of digestion is thus interrupted, not only that the body derives no strength from the inert mass of ingesta, but that mass, by undergoing a putrid instead of peptic decomposition, vitiates the humors of the system it was intended to nourish, irritates the sensitive membranes of the stomach, and gradually impairs the vigor of the whole digestive apparatus. Hence the gastric torments of poor overworked teachers, who (unlike happier servants of the public) can not shirk their work, and have to snatch their dinner during a brief interval of the hardest kind of mental drudgery. Hence the sallow complexion, the hollow eyes, and the weary gait of thousands of city clerks, scholars, lawyers, newspaper drudges, and even physicians. Housewives, after dinner, have generally the good sense to rest awhile, often a very good while, and thus manage to digest their food; for, that their immunity is not a prerogative of their sex is demonstrated by the chlorotic complexion of lady-teachers and boarding-school girls, who have only an hour's recess—physiologically no recess at all, if the school-bell rings right after dinner.

For those who have to drudge the whole afternoon, it would be better to postpone the principal meal to the very end of the day, and laugh at the supposed danger of "sleeping on a full stomach." For what do those who add a supper to an undigested dinner?—only with this difference, that their stomachs are obliged to dispose of an acidulated *mélange*. Animals, in a state of nature, nearly always sleep or rest after a heavy meal; only the *homo sapiens* disregards the promptings of his instincts, and relies on a dyspepsia-pill.

In most cases, however, the matter could be compromised. Early rising and an unmuddled brain would enable almost any man to go home at 3 or 4 P. M., and counting-house clerks should consent to a reduction of their wages rather than forego the same privilege; at five, a full meal of milk, farinaceous preparations, and nutritive vegetables, followed by a dessert of fresh or cooked fruit; then a *siesta* of two full hours, music, conversation, or, *faute de mieux*, an entertaining book; then, the weather permitting, a ramble in the cool evening air, or light gymnastics; then rest in undress, an air-bath, and open bedroom-windows.

The general adoption of that plan would soon dissipate a strange and strangely prevalent fallacy: the supposed natural antagonism of the brain and the stomach—the alleged impossibility of combining studious habits with a sound digestion. Restricted to proper hours, head-work is as stimulating as any other kind of labor, and promotes digestion instead of hindering it. The nature-abiding habits of such men as Boileau, Linnæus, Cuvier, Goethe, and Humboldt, enabled them to reconcile the mental strain of their enormous literary activity with the enjoyment of almost uninterrupted health.

Dyspeptics, therefore, need not shirk brain-work, but, as they would shun the pills of a mercury-quack, they should beware of

exasperating mental emotions. For it is a curious and not quite explained but incontestable fact that a short fit of anger is often enough not only to derange but to completely arrest the digestive process for a whole day. Close behind the stomach is a group of ganglia, the solar plexus, which sends out a large number of nerve-filaments that communicate with the brain, and thus suggest the physiological explanation of the curious phenomenon, though its final or teleological purpose is somewhat less apparent. Haller connects it with the fact that anger vitiates the saliva (*teste*, the virulent bite of enraged animals), and suggests that by a wise arrangement of Nature the suspension of the assimilative process may preserve the chyle from the contamination of malignant humors; and, in connection with the same subject, Camper mentions the circumstance that *fear* often acts as a sudden cathartic, perhaps for the purpose of easing the stomach, and thus preparing the body for emergencies—the necessity of flight, for instance. Speculations of that sort lead to a field of curious but rather recondite biological metaphysics; but the empirical fact remains, and partly suggests the *rationale* of another fact—namely, that pleasurable mental emotions act as a benignant digestive tonic. Hence, perhaps, the peptic beatitude of "jolly paunches," fellows who seem constitutionally unable to see the gloomy side of earthly concernments, and wax fat on the prescription of Democritus, "*Ride, si sapis.*" The autocrat of the dinner-table should, therefore, peremptorily exclude all conversational topics of an irritating character, as well as all business-talk. A remarkable influence on the action of the bowels can be exerted by *mechanical laughter*—I mean, the agitation of the diaphragm by means of a forcible and long-continued chuckle. Laurence Sterne mentions that he was able to keep up this factitious kind of laughter for minutes together, with or without the association of risible ideas. On solitary evenings that talent could be utilized as a physiological compensation for the absence of merry friends.

For the effects of mental worry, and nervousness (often the after-effect of stimulating medication), the best remedy, next to out-door work, is a *liberal allowance of sleep;* and metropolitans who can not afford to join the summer exodus should at least remove their beds to a suburban cottage, far from the sleep-murdering noise of the business centers.

But neither long sleep nor short meals can save dyspeptics who will insist on swallowing their food smoking hot. The walls of the stomach are lined with a nerve-interwoven delicate membrane, which suffers from scalding fluids as much as any other tegumental tissues of the body, and by daily torrefactions becomes either callous or chronically inflamed, and in either case less fit for the performance of its important functions. Our forefathers served their viands steaming hot, but stuck at least to cool drinks, but hot French soups were soon followed by hot tea and hot coffee. The "second breakfast," as

the Germans call the eleven-o'clock refreshment, used at least to consist of cold meats; but competing saloon-keepers have now introduced hot lunches, and in our larger cities there is no escape for dyspeptics; "the smoke of their torment ariseth for ever and ever."

The gastric irritability which forms a lingering after-effect of chronic dyspepsia can be better allayed by *a vegetable diet* than by the nutritive extracts which are supposed to aid the work of digestion. The *bulk* of innutritive admixtures somehow excites and maintains the vigor of the digestive organs; and the human organism can not thrive on concentrated nourishment, as for similar reasons the lungs can not be fed on pure oxygen. *Water*, either pure or in organic compounds, is likewise an effective sedative and depuratory; it aids the process of eliminating the indigestible or noxious elements of various articles of food, whose ingestion therefore excites thirst. But, without waiting for that urgent appeal, we should remember that the diet of our instinct-guided relatives contains about ninety per cent of water, and that a dearth of fruit should be compensated by artificial compounds, supplying the requisite amount of fluids in a palatable form. The remedial influence of many famous spas is due to the water as much as to its mineral admixtures. About fifty years ago, the Brooklyn hotels were crowded with visitors, attracted by the fame of a doctor who cured all manner of diseases with pure rain-water. The mystic motto of Thales, "*Ariston men hydor*" ("The best of all things is water"), might perhaps be explained from such facts. Our diet, in fact, is much too dry, and could be improved without resorting to lager-beer, which redeems its deleterious influence to some degree by helping the Germans to digest their pungent comestibles. Water, in some of its combinations, is also an effective aperient; in watermelons and whey, for instance; but still more in conjunction with a dish of *legumina*—peas, lentils, and beans. No constipation can long withstand the suasion of a daily dose of pea-soup, or baked beans, flavored with a modicum of brown butter, and glorified with a cup of cold spring-water; and, moreover, the aperient effect is not followed by an astringent reaction—the cure, once effected, is permanent. Plethoric dyspepsia is almost invariably accompanied by close stools, and the drugs that have been swallowed to ease Nature—for a day—would poison half the living creatures of the American Continent.

But rather forego the beans than eat them with *pork*. The interdict of the Hebrew lawgiver, I suspect, has something to do with the climate-proof health of his countrymen, for in warm weather fat pork is about as digestible as yellow soap. The Hungarian peasants are ravenously fond of it, and neither out-door life nor the vigor of their Turanian stomachs can save them from the consequences. Every summer, and sometimes three and four times a year, the digestive system of the rustic Magyar relieves itself by an expurgative process known

as the *tzömör*, or pork-surfeit, a three days' purgatory of heart-burns, nausea, and violent retching, accompanied by a burning thirst and an unspeakable loathing of all solid food. He who weathers the storm, says the traveler Kohl, feels like a new-made man, and reappears at the family table; but so does the pork-pot, and a few months after the respited sinner has another seizure, and groans, "O Jesus, Maria, *meg tzömöretem*—it's got me again!"

After the re-establishment of intestinal digestion, flatulence, vertigo, and that terror of constipated tea-drinkers, dull headache, become less and less frequent; the spell of the deliquium is broken, and the redevelopment of the wasted muscles proves that the system is no longer obliged to feed upon its own tissue. But these first symptoms of improvement should not encourage the patient to relax the rigor of the regimen before he is sure that the gastric inflammation has wholly subsided. As long as spasms and acrid eructations (water-brash) indicate the danger of a relapse, give the stomach all the *rest* you can. Never miss an opportunity that will make it easy to forego a meal or two. There are ways to make a fast-day a very trifling inconvenience, and its remedial value exceeds that of a round-trip to all the spas of the Eastern Continent. In my experiments on the operation of the fasting-cure, I have noticed the curious fact that for the first day or two the clamors of the stomach are restricted to certain hours, and can be induced to waive a disregarded claim. Convalescents who have already reduced the morning lunch to the standard of a Spartan breakfast, a "heathen fig and a thrice-accursed biscuit," can beguile the dinner-honr by diverting pastimes—a boat-trip, a fishing-excursion, a visit to the Zoo—and upon their return home will find that the craving for food has yielded to sleepiness, and the sweetness of the night's rest will be worth seven meals. It is during such periods of undisturbed rest that the work of repair makes its surest progress, and for the first three or four months it would be a good plan to imitate the example of the Ebonite heretics, who observed a weekly fast-day in the Ugolino sense of the word. Water, of course, should never be stinted, and, after a long fast, will have an especially good chance to depurate the vacated passages of the abdominal labyrinth.

An advanced stage of alcoholism (which will be treated in a separate chapter) often results in that malignant form of chronic indigestion known as hepatic or bilious dyspepsia, a complete derangement of the digestive process, accompanied by headaches, which for months defy the influence of an hygienic regimen, and yield only to the heroic remedies of the pedestrian-cure. But, with that exception, ten weeks of strict temperance, fresh air, and moderate exercise, will generally suffice to appease the resentment of the outraged stomach. During the next twelve months the reconciled digestive apparatus helps to redress the impairments of other organs. For it is a generic peculiarity of dyspeptic affections that the symptomatic outlast the idio-

pathic disorders. After the action of the bowels has become perfectly regular, after fat and sugar have ceased to cause heart-burn, the chronic lassitude—not pain exactly, but a nervous disinclination to active exercise—still lingers about the knee-joints; the flexor muscles of the upper arm still shirk their work; headaches that can not always be traced to dietetic backslidings recur at irregular intervals. The countenance is still sallow, the eyesight more or less impaired; even vertigo and murmurs in the ears occur, without their former gastric concomitants. But at the end of each month the progress in the direction of general health is unmistakable. Mountain excursions marvelously further the good work; but even the counting-house drudge need not doubt the reward of his perseverance, as long as he sticks to a plain diet, and such exercise as the opportunities of his leisure will offer on all but the busiest days. Unlike consumption (which can only be made non-progressive), dyspepsia can be thoroughly cured. As far as they are capable of repair, injuries to the respiratory organs heal quickly; gastric ailments with less ease but more completely.

Gymnastics, however, combined with cold-baths, air-baths, deep draughts of cold spring-water, dietetic aperients, temperance, abstinent forenoons, liberal *siestas*, cheerful evenings, and wide-open bedroom-windows, will speed the advent of the time when the after-dinner hour shall cease to be the "saddest of the sad twenty-four"—nay, when digestion, like all normal functions of the animal organism, shall be once more not only a painless but a pleasurable process.

UNWRITTEN HISTORY.*

By Professor T. H. HUXLEY.

I DOUBT not that you all joined in cheering Lord Wolseley and his companions in arms the other day, when they came to Windsor to receive their well-earned honors at the hands of the sovereign. If I had been among you I should have given a special cheer, on my own account, to the general—not so much to the successful soldier as to the man of science, who had thoroughly studied the conditions of the problem with which he had to deal; who knew what causes would produce certain desired effects; and whose experiments were followed by the predicted results more surely than sometimes happens with those which are made on a lecture-table.

But a much larger interest attaches to the day of Tel-el-Kebir, with all that preceded and followed it, than if it were an isolated experimental investigation of the great "survival of the fittest" prob-

* A lecture to the Eton Volunteer Corps, with some additions.

lem. These events of yesterday are but the latest episodes of a struggle between the social organization of Asia and that of Europe for predominance in the countries which border the Ægean and the Levantine Seas, which has been going on for some thousands of years. To say nothing of earlier events, Marathon, Thermopylæ, Salamis, the expedition of Alexander, the Punic wars of Rome, the Saracen occupation of Spain, the Crusades, the Turkish conquest of the Balkan Peninsula, the Egyptian expedition of the first Napoleon, are names of some of the long score of matches and return-matches played between East and West in the terrible game of war. And, in my judgment, the grandson of the youngest boy here is not likely to see the winner finally declared. For the contest depends not upon mere dynastic interests, or the lust of conquest, but is the inevitable product of the struggle for existence between incompatible forms of civilization, antagonisms of religion, and antipathies of race.

Twenty-four centuries, mainly occupied in fighting, do not afford a very pleasant retrospect at the best, and it would be altogether horrible, were not the affairs of this world so ordered that "there is a soul of good in things evil." No doubt millions of men, women, and children have suffered grievous misery and wrong, and whole nations have been annihilated, as the tide of conquest swept over them—now to the west, and now to the east. All that is sadly obvious, and, to those who can see only that which is obvious, these wars, like all others, must take the guise of purely diabolical evils. But a more patient and penetrating vision may discern that all this suffering is the school fee which the human race has had to pay for its education. As elsewhere, bright and dull pay alike, and the bright profit; which is, perhaps, no great satisfaction to the dull, but it is the rule of the school, and we have to put up with it.

In the present case, the Western nations are the bright boys. Your teachers of history are doubtless careful to point out to you all that ancient Greece owed to its intercourse, whether hostile or peaceful, with the East; all the benefit which Saracen learning on the one hand, and crusading enterprise on the other, conferred on Europe in the middle ages, and how much the Turks, quite unintentionally, did for the revival of learning. It is not to such familiar truths as these that I wish to direct your attention, but rather to the fact that history, in the modern sense of the word, was born of the very earliest of the struggles to which I have adverted.

I say history, in the modern sense of the word, that is, not barely a chronicle of events and record of current traditions or venerable myths, but a narrative based upon evidence which has been critically sifted, and in which the narrator endeavors to trace, amid the tangled occurrences of human life, the thread of natural causation which connects them with the needs and the passions of men. The chronicler is more or less of a gossip, the historian more or less of a man of science. For

that which constitutes a man of science is not the pursuit of this or that specialty, but a living faith in the supreme importance of truth, and an unshakable conviction that order reigns over all things, and that chance has no more place in human affairs than elsewhere.

Now, the generation of the science of history took place in this wise: Somewhere in the earlier half of the fifth century, a sort of side skirmish of the Persian wars drove out of house and home a Greek gentleman—one Herodotus, with whose name you will be sufficiently familiar. He was a man of great intelligence and unflagging energy, well versed in all the learning of his time. The magnitude and the interest of the events which had taken place, either within his own memory or within that of men with whom he had talked, seem early to have taken strong hold of his mind, and he determined to devote his life to writing an account of them, in which truth should be sifted from error, and the causation of events displayed to the best of his ability.

With this end in view, Herodotus was not content with collecting and collating all the information which he could obtain from trustworthy sources, but he determined to become personally acquainted with the chief countries and people implicated in the contest. There lay the primary conditions of the problem which "the father of history" had set himself to study; and there is no better evidence of his strong scientific turn than the conviction on which he acted, that, if he would understand these conditions, he must know them of his own knowledge.

Egypt was one of the countries involved in the Persian wars. Herodotus visited the country somewhere about 450 B. C., and he has left a most curious and entertaining account of his own observations, and of the information which he obtained from the priests of Thebes and the *literati* of Heliopolis, with whom his interpreter, or dragoman, as we should now call him, brought him into contact.

I dare say you read the second book of Herodotus, and know a great deal more about it than I do. Nevertheless, it may not be superfluous to remind you that the historian speaks with admiration of the learning of the Egyptians, and of the remarkable pains which they took to preserve the memory of the past in their records. Among a great many other things, they read to him from a papyrus the names of three hundred and thirty monarchs who had reigned over Egypt, from Menes, the first Pharaoh, to their own time.

The average length of the reigns of any long series of Western sovereigns is about twenty-five years, so that, if the records of the Egyptians were to be trusted and the average length of reign among them was the same, Menes should have ascended the throne more than ten thousand years ago.

Within my recollection it was very much the fashion to regard Herodotus as a garrulous old gentleman, who willingly allowed himself

to be crammed with interesting fictions; and the pretension of the Egyptians to such prodigious antiquity of their state was regarded as one of the most patent examples of such figments. Yet it is probable that, in respect of this and other pieces of information of like character, the learned Egyptians said no more, not only than they fully believed, but than they might fairly enough think they had good reason for believing; and modern investigations have shown that they were certainly much nearer the truth than sundry of their critics.

Among the achievements of scientific method in this century, none is, to my mind, more wonderful than the disinterment of so much of a past, to all appearance hopelessly dead, by the interpretation of the hieroglyphic and cuneiform inscriptions in which the ancient inhabitants of the valleys of the Nile and the Euphrates chronicled the events of their history. Thanks to the sagacity and the untiring toil of such men as Lepsius—just about to receive the congratulations of all the world on the completion of half a century of fruitful labor—of Birch, of Mariette, of Brugsch, the student of Egyptology, guided by the spirit of scientific criticism, is probably far more accurately informed about the ancient history of Egypt than was the whole College of Heliopolis in Herodotus's time.

An exact chronology of Egyptian history is yet to be constructed; but those best qualified to judge agree that contemporary monuments tell us of the state of Egypt more than five thousand years ago; and since they prove, beyond the possibility of doubt, that the people who erected them possessed a complex social organization, as replete with all the necessaries and conveniences of life as that of any nation in Europe in the middle ages, and not inferior in literature or in skill in the arts of painting, sculpture, and architecture, it is but rational to conclude that, even at this farthest point of time to which written records take us, the Egyptian people had, for long ages, left barbarism behind, and constituted a settled and a civilized polity. So that, whether Menes was followed by three hundred and thirty kings or not, the general impression of the vast antiquity of the Egyptian state which Herodotus received, and has transmitted to us, has full justification.

But that which is so characteristically modern about Herodotus is that he was not satisfied to stop where written records halt, or to accept traditional accounts of an earlier time without discussion. His informants told him that, when Menes began to reign, Lower Egypt was covered with water, a dismal and pestilent swamp, and that the first Pharaoh drained and rendered habitable that alluvial soil which they called "the gift of the Nile."

Herodotus was evidently very much interested in this statement. Perhaps he asked his Heliopolitan friends how they knew this. Perhaps they answered him as they did a countryman of his, ("You Greeks always were and always will be children,") asking the why of the wherefore. A true saying, which, however it may have been intended,

conveys high praise. For it is just because it is true that these mighty children became the fathers of natural knowledge. Men of science are eternal children, always asking questions of Mother Nature, and never content with her answers.

But, whether questions are childlike or childish, depends upon the knowledge and the intelligence of the questioner; and Herodotus, as I have said, was largely endowed with both. Let me remind you that he lived midway between Thales and Aristotle, in the very heart and center of the great age of Greece; and let me also remind you of the fact, of which people too often remain ignorant throughout their school and university career, that, if this was an epoch of great achievements in art, in literature, and in philosophy, it was no less distinguished for the sedulous cultivation of physical science. Democritus, the contemporary of Herodotus, was the great exponent of principles which have played, and still play, a great part in modern scientific speculation. Half a century before Herodotus, Xenophanes had observed petrified marine shells and fish-bones in the quarries of Syracuse and elsewhere; he had drawn the conclusion that the rocks in which they were contained were the hardened mud of the bottom of the sea in which the corresponding animals once lived; and he had laid down the general proposition that the geographical features of our earth are not constant, but that where land now is, sea has been, and where sea is, land has been. And it is a corollary from this proposition that the land which constitutes any country has not always been what it is and where it is, but that it has a history, unwritten save in the hieroglyphics of Nature. Herodotus is not likely to have been ignorant of the speculations of Xenophanes, but it is in evidence that his extensive travels had enabled him to observe facts which led directly to like conclusions. The plain of Ilium and the estuary of the Mæander had shown him rivers at work in the formation of new land, and he adverts to the conclusions to be drawn from the presence of shells in the rocks which bound the Nile Valley.

To a mind thus prepared by an acquaintance with elementary truths of physical science, the first glance at Egypt can not fail to suggest inquiry, and, in fact, Herodotus says as much:

"Any one who sees Egypt, without having heard a word about it before, must perceive, if he has the least intelligence, that the Egypt to which the Greeks go in their ships is a gift of the Nile to the Egyptians."* That is to say, as he elsewhere explains, the rich soil of the great plain, or so-called Delta of Egypt, has been formed out of the deposits left by the Nile during the annual inundation. The region occupied by the delta, he adds, was "evidently, at one time, a gulf of the sea. It resembles, to compare small things with great, the parts about Ilium and Teuthrania, Ephesus, and the plain of the Mæander. In all these regions the land has been formed by rivers, whereof the

* Those and other citations are taken from Rawlinson's "Herodotus."

greatest is not comparable in size with any one of the arms of the Nile." After comparing the valley of the Nile with that of the Red Sea (which Herodotus appears not to have visited, and of the magnitude of which he has a very inadequate conception), he goes on to say: "Now, if the Nile should choose to divert his waters from their present bed into the Arabian Gulf, what is to prevent it from being filled up by the stream within twenty thousand years at most? For my part, I think it might be filled up in half the time. Why, then, should not a gulf of even much larger size have been filled up in the ages before I was born, by a river which is so large and so given to working changes as the Nile?"

It is on the strength of these very sound and just physical considerations that Herodotus tells us he accepted Egyptian tradition:

"Thus I gave credit to those from whom I received this account of Egypt, and am myself, moreover, strongly of the same opinion, since I remarked that the country projects into the sea farther than the surrounding shores, and I observed that there were shells upon the hills." Finally, he inquires into the origin of the population of Egypt:

"I do not believe that the Egyptians came into being at the same time as the delta. I think they have always existed, ever since the human race began. As the land went on increasing, part of the population came down into the new country, part remained in the old settlements."

Thus Herodotus commits himself to four very definite propositions respecting the unwritten history of Egypt:

1. That the delta was once an arm of the sea.

2. That it has been filled up and converted into dry land by the alluvial deposits of the Nile.

3. That this process of conversion into dry land probably took something like twenty thousand years.

4. That the Egyptians existed before Lower Egypt, and migrated thence from Upper Egypt.

And it will be observed that the first three of these propositions at any rate are not mere guesses, but conclusions based upon a process of reasoning from analogy, just as sound in form as any which is to be met with in the discussion of a similar problem in a modern treatise on geology.

Herodotus wrote twenty-three hundred years ago. In the course of twenty-one out of the twenty-three centuries which have elapsed since his time, I am not aware that any one rose above his level in the discussion of such problems as that which he attacked. And some quite modern writers have not yet reached it, for lack of as much knowledge of natural phenomena as Herodotus possessed. Let us look at the facts by the light of such knowledge of elementary physical science as is now happily accessible to every Etonian.

It has often been said, and with perfect truth, that Egypt is a land by itself, unlike any other part of the world. On approaching Alexandria from the sea, nothing can be less attractive than the flat shore which stretches east and west as far as the eye can reach, without an elevation of more importance than bare and barren sand-dunes to break its even line. This monotonous coast extends for two hundred miles between the most extreme of the ancient arms of the Nile, from the Canopic in the west to the Pelusiac in the east, and forms the northwardly turned base-line of the triangular area of Lower Egypt, the shape of which led the Greeks to call it the delta.

In the journey from Alexandria southward to Cairo, the traveler finds himself in a boundless plain, as flat as the flattest part of Lincolnshire or of Holland. At first, rising only here and there above the level of the Mediterranean, it is full of morasses and stagnant lakes of great extent, the waters of which vary from salt to fresh, and from fresh to salt, according as the Nile or the Mediterranean is the predominant contributor to their contents. Beyond this region, the wide expanse of black alluvial soil, intersected by innumerable water-courses, departs from absolute horizontality, rising some three or four inches in the mile. Here and there, low mounds bearing groups of date-palms, or thickets of sycamores and acacias, indicate the deserted site of an ancient city, or preserve from the periodic floods the assemblage of hovels which constitutes a modern Egyptian village. In autumn, the soil, save these mounds and their connecting dikes, disappears under the overflow of the flooded Nile; in early spring, the exuberant vegetation of the young crops no less completely hides it under a carpet of the brightest imaginable green.

For more than a hundred miles, as the crow flies, this is the general character of the country between Alexandria and Cairo. But, long before the latter city is reached, the plain begins to be limited by distant heights which spring up on either hand. First, a ridge of low hills makes its appearance on the western or Libyan side; and then, a range of more distant but bolder and loftier heights shows itself, far away, on the eastern or Arabian horizon. With every advance southward the plain diminishes in extent, while its Libyan and Arabian boundaries approach, until, at Cairo, they are not more than six or seven miles apart.

Nothing can be more sharply contrasted than the aspect of the plain and that of its limitary heights. For the low, rounded ridges on the west and the higher plateau with its steep and cliffy face on the east are utterly waterless—mere wastes of bare rock or sand—without a bush or a patch of soil on which it could grow, to veil their savage nakedness. Under our own pale and faintly-lighted sky, such bare hills and rugged cliffs as those which bound the prospect here and everywhere in Upper Egypt would fitly represent the abomination of desolation. But, framed as they are in an atmosphere of limpid purity,

with lights and shades and tints endlessly varying in shape and hue, from hour to hour, and almost from minute to minute, as the sun runs his course, they have a strange and unique beauty. Moreover, in early spring, the edges of the greenery of the plain lie sharply defined against the yellow sands and gray-brown stones of the waste as if it were so much water.

When I was in Cairo, ten years ago, I delighted in wandering about the heights of the Mokattam range, which rise for some four or five hundred feet immediately to the east of the city. The Sahara itself can not better deserve the name of desert than do these stony solitudes. Looking westward at sunset, the vultures, diminished to mere crows, wheeled about the face of the cliffs far below. Beneath and beyond them, the green expanse stretched northward, until it became lost in the horizon; while, toward the west, its even line followed the contour of the Libyan shore, as if it were the veritable sea-water of the Gulf of Herodotus. And sharply defined against the western sky, the great pyramid, which, even in its present mutilated state, reared its summit to the level of my eye, threw its long shadow eastward like the gnomon of an appropriately gigantic dial-plate.

Indeed, the comparison is not far-fetched. For the great shadow has veritably swept, from west to north and from north to east, day after day from the dawn of civilization till now; since the toiling subjects of Chufu, with patient and skillful labor, piled the great stones of his tomb, one upon another, it has marked the birth-hour, and sometimes the death-hour, of each great nation known to history.

For all these ages, day after day, the shadow, as it lengthened eastward, has swept over the weary heads of thousands upon thousands of orderly, cheerful, hard-working men, women, and children, who have been plundered, starved, beaten, decimated, now to serve the ambition or gratify the superstitious vanity of an ancient Pharaoh, and now to enable some thinly varnished savage of a modern Khedive to subsidize his opera troupe in Cairo, and squander the price of their blood among foreign harlots and foreign swindlers.

Six thousand years of grinding oppression, worse than it ever was during the last few centuries, seemed to me a curious reward for laying the foundations of civilization; and yet there was no sign that the great shadow was likely, for another century or so, to mark the hour when Khedive, mudirs, commercial Mamelukes of various nationalities, and all the rest of the "wolves that with privy paw devour apace and nothing said" should be swept away to make room for that even moderately decent and intelligent rule which is all the Egyptian people need to become, at last, a contented and a wealthy nation.

But this, I say, was ten years ago; many things—Tel-el-Kebir among the rest—have happened since then; and perhaps the good time may be coming. At any rate, the great British panacea—constitutional government—is to be administered; and if the Fellaheen

sheep do not find their affairs much improved when the representatives of their interests are mostly mongrel Arabo-Turkish wolves (as they certainly will be), they must be unfit for free institutions, and we may wash our hands of them, conscious that we have exhausted the resources of political science in our intelligent efforts to improve their condition.

The extent of the land now under cultivation in Egypt is estimated approximately at 7,300 English square miles—that is to say, its area is about a fifth greater than that of the valley of the Thames (6,160 square miles). One half of this cultivated land lies in the delta, and the other half in Upper Egypt. Under the Pharaohs, the cultivated area was of considerably greater extent; but not even the industry and thrift of the Fellaheen have been able to make head against the ignorance, sloth, and greed of their later rulers.

Above Cairo, the Libyan and the Arabian boundaries of the narrow valley of Upper Egypt, which runs in a southerly direction, through 6° of latitude to Assouan in 24° north, are approximately parallel, here approaching and there diverging from one another, though they are rarely more than ten or fifteen miles apart. The general inclination of the bottom of the long and winding stream, though rather greater than in the delta, does not exceed five or six inches in the mile. Hence, Assouan, some five hundred miles distant, in a direct line, from Alexandria, is little more than three hundred feet above the Mediterranean.

In Upper Egypt there is still less rain than in the delta. For, though violent storms, accompanied by a heavy down-pour, occur at intervals of perhaps twenty years, filling the parched ravines of the desert with short-lived torrents, there is usually either no rain, or, at most, a passing shower, in the course of each year. Hence, not only the boundaries of the valley, but all the country eastward as far as the Red Sea, and all westward (save where a rare oasis breaks the monotony of the waste) for hundreds of miles across the Sahara, over which the same meteorological conditions prevail, is, if it be possible, even more arid and barren than the desert which bounds the delta.

What are known as the "tombs of the kings" are excavated in the walls of a deep gorge which runs from the plain of Thebes far into the Libyan Hills, the steeply escarped faces of which rise twelve hundred feet above the river. From the summit of one of these hills a panorama of appalling desolation presents itself. Except where the Nile lies like a brown ribbon, with a broader or narrower green fringe on either side, north, south, east, and west, the eye rests on nothing but rugged heights of bare rock, separated by a perfect labyrinth of steep-walled valleys. Baked during the day by a cloudless sun, cooled, not unfrequently down to the freezing-point, at night by radiation through the vaporless air, the surface-rocks are shattered by the rapid

expansion and contraction which they undergo, as if they had been broken by a road-maker's hammer; and the fragments collect in great heaps at the bottom of every steep incline. Not a blade of grass, not a drop of water, is to be seen anywhere; and yet the form and arrangement of the ravines are such that it is impossible to doubt that they have been formed, like other valleys, by the scoring and denuding action of rapid streams.

I remember that one day, wandering in the desert, northeast of Cairo, in the direction of the petrified forest, I was exceedingly struck with the resemblance of the superficial scorings of the surface of the rocky soil to those which are ordinarily made by rain. I was puzzling myself to account for the fact, when a sudden storm, accompanied by very heavy rain, came up, drenched me to the skin and vanished, all in less than an hour. Immediately after the rain began to fall, every one of the ramified scorings which had interested me was filled by a stream of water, rushing to join with its fellows and flow down some bigger groove to a lower level. It was obvious that the resemblance which had struck me was not deceptive, and that all these ramified scorings were miniature "wadys"—the dry beds of minute rivulets produced by former sudden showers of the same sort as that which I had experienced.

It was a capital lesson in physiography, and I did not forget it when I looked down on the great wadys of the Libyan desert at Thebes. Twelve hours' heavy rain would send a roaring torrent, sweeping before it all the accumulated *débris* of years, down every one of them. And if we suppose the process repeated only every twenty years; still, since the Libyan Hills have been where they are for the last ten thousand years, five hundred repetitions of the application of this most efficient rain-plow would have cut some pretty deep furrows, even if, during all this time, rain has never been more frequent or more abundant than it is now.

Still farther to the south, about El Kab, close upon the twenty-fifth parallel of latitude, the fringe of cultivable land which borders the Nile becomes narrower and narrower, and the limestones in which the valley has hitherto been excavated are replaced by sandstones as far as Assouan. The low hills of such rock (rarely more than two hundred feet high) which lie on each side of the river at Gebel Selsileh, about forty miles north of Assouan, approach one another so closely that the gorge through which the stream passes is little more than one thousand feet wide. There is every reason to believe that the opposite walls of this gorge were once continuous, and that the river swept as a rapid over the correspondingly elevated margin of the sandstone plateau, through which it has since cut its channel back to Assouan, until, at present, its bed, for the forty miles to that place, has no greater inclination than elsewhere.

Near Assouan, under the twenty-fourth parallel, on the frontier of

Nubia, the granitic masses of the desert on the eastern or Arabian side spread suddenly to the westward, and come to the surface in place of the sandstones. In the course of the six or seven miles between Assouan and Philæ the bed of the river rises sixteen feet,* forming a declivity, down which the stream rushes in a rapid, known as the First Cataract. The alluvial soil has almost vanished, and the river flows amid a confused heap of granite blocks, with black and polished surfaces. For some eight degrees of latitude farther south, the granite and sandstone plateau which rises so suddenly at Assouan extends through Nubia, increasing in elevation, until at the foot of the second cataract (Wady Halfa) the level of low Nile reaches 392 feet; at the third cataract, 659 feet; at the fourth, 745 feet. Where the White and Blue Niles join, just below Khartoum, in 16° north, the river is 1,212 feet above the sea, or more than 900 feet above its height at Assouan.

Throughout the whole of this course the Nile receives but one affluent, the Atbara, which carries the drainage of a part of Abyssinia into it in about 18° north. And, as this solitary tributary is wholly inadequate to make good the loss which the main stream suffers by evaporation and percolation, on its course through thirteen degrees of one of the hottest and driest climates in the world, the Nile presents the singular spectacle of a river the volume of water in which is conspicuously less than that poured into it by its feeders.

The Blue and the White Niles, which unite to form the main stream close to Khartoum, are in fact very large rivers, each of which drains an immense area abundantly supplied with water. The one receives the overflow of the great equatorial Nyanza lakes and the drainage of the vast swampy region of the Soudan to the north of them, in which the heavy intertropical summer rains accumulate. The other is fed not only by such rains, but by the snows among the mountain-tops of Abyssinia, which melt as the sun advances to the northern tropic.

The height of the water in the Nilometer at Cairo is contingent upon the meteorological conditions of a region more than a thousand miles off; and the question whether Egypt shall have a year of famine or a year of plenty hangs upon the rainfall in Abyssinia and equatorial Africa. It is as if the prosperity of the agricultural interest in Berkshire depended on the state of the weather in Morocco.

The general course of the Nile is so directly north and south that the thirtieth parallel of east longitude, which traverses the Albert Nyanza Lake on the equator, passes close to the Rosetta mouth at its outfall. The Albert Nyanza is 2,500 feet above the sea; and, since the length of the part of the great circle inclosed between the points

* The heights of points in the course of the Nile, given in books, are widely discrepant and usually very inaccurate. I am indebted to the eminent civil engineer, Mr. John Fowler, for this and subsequent precise determinations. The height of low Nile above the sea is 303 feet at Assouan, 319 feet at Philæ.

just mentioned is more than two thousand English miles, the mean inclination of the river, if it ran straight, would somewhat exceed a foot per mile. Taking the actual bends into consideration, however, it must be considerably less than this amount.

Without a knowledge of the facts thus briefly sketched, the periodical inundation of the valley of Egypt by the Nile is unintelligible. And, since no one till long after Herodotus's time possessed such knowledge, we may proceed to consider this singular phenomenon without troubling ourselves about his curious speculations as to its causes.

In the month of May and the beginning of June, the Egyptian Nile is little better than a great sluggish ditch, the surface of which, in Upper Egypt, lies many feet below that of its steep banks of irregularly stratified mud and sand. A short distance north of Cairo, it divides into two main branches, which take a northerly course through the delta and finally debouch, the one at Rosetta and the other at Damietta. Innumerable artificial canals connect these arms of the Nile with one another, and branch off east and west for purposes of irrigation; while, in the north, the complex system of water-courses communicates with the series of lakes and marshes, from Mariout, on the west, to Menzaleh on the east, which, as I have already said, occupy a large portion of the area of the delta southward of the sea-coast.

In the latter part of June, about the time of the summer solstice, the motion of the torpid waters of the Nile seaward is quickened, and their level rises, while at the same time they take on a green color. The rise and the flow quicken, and the green color is succeeded by a reddish brown; the water becomes turbid and opaque, and is found to be laden with sediment, varying in consistency from moderately coarse sand, which falls to the bottom at once when the water is still, to mud of impalpable fineness which takes a long time to subside. In fact, when the sun approaches the northernmost limit of his course, as the snows of Abyssinia begin to melt, and the heavy intertropical rains set in, a prodigious volume of water is poured into the White and Blue Niles, and drives before it the accumulated living and dead particles of organic matter which have sweltered in the half-stagnant pools and marshes of the Soudan during the preceding six months. Hence, apparently, the preliminary flow of green water. The Blue Nile and the Atbara must sweep down a vast quantity of river-gravel from the Abyssinian uplands, but it may be doubted whether any of this gets beyond the middle cataracts, except in the condition of fine sand. And I suspect that the chief part, if not the whole, of the coarse sediment of the waters of the high Nile must be derived from Nubia, from the weathering of the rocks, by the heating and cooling process already described, and the action of the winds in blowing the sand thus produced into the stream. The Nile continues to rise for three

months until the autumnal equinox, by which time the level of its surface at Assouan is usually forty feet, at Thebes thirty-six feet, at Cairo twenty-four or twenty-five feet, and at Rosetta four feet higher than it is in May ; and, before reaching the delta, it flows at the rate of three or four miles an hour.

Under these circumstances, the river overflows its banks on all sides. When it does so, the movement of the water is retarded or even arrested, and the suspended solid matters sooner or later fall to the bottom, and form a thin layer of sandy mud. When the Nile waters spread out over the great surface of the delta, the retardation is of course very marked. The coarse sediment is soon deposited, and only the very finest particles remain in suspension at the outflow into the Mediterranean. As the sun goes southward, his action on the Abyssinian snows diminishes, the dry season sets in over the catchment basin of the White Nile, and the water-supply of the Nile diminishes to its minimum. Hence, after the autumnal equinox, the Nile begins to fall and its flow to slacken, as rapidly as it rose. By the middle of November, it is half-way back to its summer level, and it continues to fall until the following May. In the dry air of Nubia and of Egypt, evaporation is incredibly rapid, and the Nile falls a prey to the sun. As the old Egyptian myth has it, Osiris is dismembered by Typhon.

Relatively to the bulk of water, the amount of solid matter transported annually by the Nile must be far less than that which is carried down by the rapid streams of mountainous countries in temperate climates—such, for example, as the upper Rhône. We have no very satisfactory estimate of what that amount may be, but I am disposed to think that the ordinary computation, according to which the average deposit over the delta amounts to not more than a layer one-twentieth of an inch thick annually, is, at any rate, not under the mark.

But this is a very interesting question, for it is obvious that, if we may assume that the deposit of the Nile has taken place uniformly at a known rate, it becomes possible, given the thickness of the alluvial deposit in the delta, to calculate the minimum time occupied in its formation. The borings made under the direction of the late Mr. Leonard Horner in the upper part of the delta, and those subsequently conducted by Figari Bey, favor the conclusion that the natural loose soil which fills the flat basin of the delta nowhere exceeds sixty feet in depth. Assuming it to have this thickness in any spot, it follows that, at one twentieth of an inch of deposit per annum, it must have taken at least fourteen thousand four hundred years to accumulate to that thickness at that place. And if so, Herodotus seems, at first, to have made a wonderfully good guess, when he said that the Arabian Gulf and, by implication, that of the delta, might have been filled up in " twenty thousand years, or even half the time."

I am afraid, however, that any such modern estimate has not a much surer foundation than the ancient guess. For, in the first place, there are many reasons for believing that the action of the Nile has not been uniform throughout the whole period represented by the deposit of alluvium; and, in the second place, if it had been, the simple process of division of the total thickness of the alluvium by that of the annual deposit does not by any means necessarily give the age of the whole mass of alluvium in the delta, or, in other words, the time which elapsed during the filling of the delta, as it is sometimes supposed to do.

According to Figari Bey, the deepest, and therefore earliest, alluvium in the delta contains gravel and even bowlders; so that, if these are fluviatile beds, which is, perhaps, not quite certain, they indicate that, at the time when they were deposited, the current of the Nile in this region was much more powerful than it is now, and, consequently, that its annual additions were much more considerable.

If the flow of the Nile in these ancient times was more rapid, the probabilities are that the volume of its waters was greater, and sundry observations have been adduced as evidence that such was the case. Thus, at Semneh, above the second cataract, Lepsius, many years ago, discovered inscriptions of a Pharaoh of the twelfth dynasty, Amenemhat III, who reigned between 2,000 and 3,000 B. C., which registered the level of the highest rise of the Nile at that time. And this level is nearly twenty-four feet higher than that of high Nile at the same place now. Another fact has been connected with this. Between the narrow gorge of the Nile at Selsileh and the first cataract, alluvial deposits, containing shells of animals now living in the river, lie on the flanks of the valley, twenty to thirty feet above the point which high Nile reaches at the present day. It has been suggested that, before the Nile cut the gorge, the sandstone bar at Selsileh, as it were, dammed up the Nile, and caused it to stand at a higher level all the way back to Semneh. But, as the late Dr. Leith Adams long ago argued, the sandstone strata of Selsileh could hardly have played the part thus assigned to them. The deposits in question indicate that the supposed barrier at Selsileh was about thirty feet high; while Semneh is at least one hundred and thirty feet higher than Selsileh.

The cause of the difference of level of the Nile at Semneh, between the days of Amenemhat and now, is surely rather to be sought in the progressive erosion of the Nubian valley. If four thousand years have elapsed since Amenemhat reigned, the removal of one thirteenth of an inch per annum from the bed of the river will be more than enough to account for its present depression. Considering the extraordinary activity of the denuding forces at work in Nubia, I see nothing improbable in this estimate. But, if it is correct, there is no need to suppose that the Nile conveyed a greater body of water four thousand years ago than it does now. Nor is there anything in

the ancient records of Egypt which lends support to such an hypothesis.

But we are indebted to Dr. Leith Adams for proof that the Nile, between the first and the second cataracts, once stood very much more than twenty-five feet above its present level. From Assouan to Derr, in fact, he observed abundant patches and continuous terraces of alluvium, containing shells of the same kinds of fresh-water mollusks as those which now inhabit the Nile, one hundred to one hundred and twenty feet above the highest level now reached by its waters; and he concludes that "the primeval Nile was a larger and more rapid river than it is now." I am disposed to think that the "primeval" Nile was so, but I question whether these terraces were made by the river in its youth. I see no reason why they should not be affairs of a geological yesterday—say, a mere twenty or thirty thousand years ago.

There can be no reasonable doubt of the correctness of the view first, so far as I am aware, distinctly enunciated by M. Louis Lartet,* that the whole of the principal valley of the Nile has been excavated by the river itself. I am disposed, for my own part, to think that the Nile might have done this great work if the mass of its waters had never been much greater than now. And, with respect to the innumerable lateral ravines which debouch into the main valley, I think it would not be safe to affirm that they could not have been excavated by the rains, even if the meteorological conditions of the country had never been very widely different from what they are now.

But, in some parts of Lower Egypt, and in the peninsula of Sinai, many of the dry wadys exhibit such massive deposits of more or less stratified materials, that it is hardly credible they can have been formed under anything like existing conditions. Indeed, in some localities, very competent observers have considered that there is good evidence of the former existence of glaciers in the valleys of Sinai. And it is well worthy of consideration whether, as Fraas and Lartet have suggested, these deposits were not contemporaneous with the so-called glacial epoch, when the climate of Northern Europe resembled that of Greenland, and when the Mediterranean covered the Sahara and washed the western flanks of the Libyan range.

Under such changed conditions, Egypt must have been one of the wet countries of the world, instead of one of the driest; and, as there need have been no diminution in the bulk of water poured in by the White and Blue Niles, the accumulation of water in the valley of Egypt, partly in virtue of its own rainfall, and partly by the dimi-

* "Essai sur la Géologie de la Palestine et des Contrées avoisinantes, telles que l'Egypte et l'Arabie," 1869. The Rev. Barham Zincke, in his interesting work "Egypt of the Pharaohs," 1871, has expressed similar conclusions; and I may say that they forced themselves on my own mind in the course of my journey to the first cataract in 1872.

nution of evaporation, may have been immense. Under such circumstances, it is easily conceivable that a swift and voluminous torrent, periodically swollen by the contributions of the great southern affluents, covered the delta with a permanent inundation, and swept down gravel and bowlders into the lowest part of its course.

That the outflow of the Nile once extended far beyond its present limits appears to be certain, for a long, deep, dry valley—so like an ancient river-bed that the Arabs call it the Bahr-bela-Ma, or waterless river—runs from south to north in the Libyan desert along the western edge of the delta, and ends in the Mediterranean shore beyond Taposiris, far to the west of the Canopic mouth, the most westerly of the outlets of the Nile known during the historical period. And, in the extreme east, far beyond the most easterly arm known to the ancients—in fact, in the middle of the Isthmus of Suez, about Lake Timseh—alluvial deposits, containing Nile shells and hippopotamus-bones, show that the Nile once extended into this region, and perhaps poured some portion of its waters into the Red Sea, by way of anticipating the engineering operations of more modern days.

These facts tend to show that any calculation of the age of the delta, based upon the present action of the Nile in the way indicated, may need to be abbreviated. But, on the other hand, there are many obvious considerations which tend the other way.

It is easy to see that the time required for the deposition of a certain thickness of alluvial soil, in any one part of the delta, can only be a measure of the time required to fill up the whole, if the annual sediment is deposited in a layer of even thickness over the entire area. But this is not what takes place. When the river first spread out from the southern end of the delta, it must have deposited the great mass of its solid contents near that end; and this upper portion of the delta must have been filled up when the lower portion was still covered with water. And, since the area to be covered grew wider, the farther north the process of filling was carried, it is obvious that the northern part of the delta must have taken much longer to fill than the southern. If we suppose that the alluvium about Memphis was deposited at the rate of one twentieth of an inch per annum, and that there are fifty feet of it, ten thousand years may be the minimum age of that particular part of the delta; but the age of the alluvium of the delta as a whole must be very considerably greater. And indeed there are some indications that the shore-line of the nascent delta remained, for a long time, in the parallel of Athribis, five-and-twenty miles north of Cairo, where the remains of a line of ancient sand-dunes are said to attest the fact. Hence, all attempts to arrive at any definite estimate of the number of years since the alluvial plain of the delta began to be formed, are frustrated. But, the more one thinks of the matter, the more does the impression of the antiquity of the plain grow; and I, for my part, have no doubt that the extreme term imagined by

Herodotus for the filling up of the Arabian Gulf—twenty thousand years—is very much below the time required for the formation of the delta.

Thus far we have traced the unwritten history of Egypt, and the gulf of the Mediterranean, postulated by Herodotus, is not yet in sight. Nevertheless, at a much more remote epoch—in that called miocene by geologists—the gulf was assuredly there.

Near the tombs of the Caliphs at Cairo (according to Schweinfurth, two hundred feet above the level of the Mediterranean), in the neighborhood of Sakkarah and in that of the great pyramids, the limestone rocks, which look so like a sea-shore, were found by Professor Fraas to display the remains of a veritable coast-line. For they exhibit the tunnels of boring marine mollusks (*Pholades* and *Saxicavæ*), and they are incrusted with acorn-shells, as if the surf had only lately ceased to wash them. At the feet of these former sea-cliffs lie ancient sandy beaches, containing shells of oysters, scallops, and other marine mollusks, with the skeletons of sea-urchins. The specific characters of these marine organic remains leave no doubt that they lived during the miocene, or middle tertiary, epoch. Marine beds of the same age occur at Ain Musa, between Cairo and Suez.

There can be no question, therefore, that, in the miocene epoch, the valley of the delta was, as Herodotus thought it must have been, a gulf of the sea. And, as no trace of marine deposits of this, or of a later age, has been discovered in Upper Egypt, it must be assumed that the apex of the delta coincides with the southern limit of the ancient gulf.

Moreover, there is some curious evidence in favor of the belief that, at this period, however remote as measured by our standards of time, the Nile flowed down from Central Africa as it flows now, but probably in much larger volume. Every visitor to Cairo makes a pilgrimage to the "petrified forest," which is to be seen in the desert a few miles to the northeast of that city. And indeed it is a spectacle worth seeing. Thousands of trunks of silicified trees, some of them twenty or thirty feet long, and a foot or two in diameter, lie scattered about and partly imbedded in the sandy soil. Not a trunk has branches, or roots, or a trace of bark. None are upright. The structure of wood, which has not had time to decay before silicification, is usually preserved in its minutest details. The structure of these trunks is often obscure, as if they had decayed before silicification; and they are often penetrated, like other decayed wood, by fungi, which, along with the rest, have been silicified.*

* See Unger, "Der versteinerte Wald bei Cairo," "Sitzungsberichte der Wiener Akademie," 1858. Dr. Schweinfurth ("Zur Beleuchtung der Frage ueber den versteinerten Wald," "Zeitschrift der deutschen geologischen Gesellschaft," 1882) considers that the trees grew where they are found, but his arguments do not appear to me to be convincing.

Similar accumulations of fossil wood occur on the western side of the delta, about the Natron Lakes and in the Bahr-bela-Ma.

All these trunks have weathered out of a miocene sandstone; and it has been suggested that, when this sandstone was deposited, the Nile brought down great masses of timber from the upper country, just as the Mississippi sweeps down its "rafts" into the Gulf of Mexico at the present day; and that a portion of these, after long exposure and knocking about in the flood, became silted up in the sandy shores of the estuary.

The greater part of the "petrified forest" is at present one thousand feet above the level of the sea, in the midst of the heights which form the eastward continuation of the Mokattam. It has, therefore, shared in the general elevation of the land which took place after the beginning of the miocene epoch. That such elevation occurred is proved by the fact that the marine beds of that period lie upon the upraised limestone plateau of Lower Egypt; and it must have reached seven or eight hundred feet, before the *Pholades* bored the rocky shore of the gulf of the delta.

A flood of light would be thrown on the unwritten history of Egypt by a well-directed and careful re-examination of several points, to some of which I have directed your attention. For example, a single line of borings carried across the middle of the delta down to the solid rock, with a careful record of what is found at successive depths; a fairly exact survey of the petrified forest, and of the regions in which traces of the ancient miocene sea-shore occur; a survey of the Selsileh region, with a determination of the heights of the alluvial terraces between this point and Semneh; and an examination of the contents of the natural caves which are said to occur in the limestone rocks about Cairo and elsewhere—would certainly yield results of great importance. And it is to be hoped that, before our occupation of the country comes to an end, some of the many competent engineer officers in our army will turn their attention to these matters.

But, although so many details are still vague and indeterminate, the broad facts of the unwritten history of Egypt are clear enough. The Gulf of Herodotus unquestionably existed and has been filled up in the way he suggested, but at a time so long antecedent to the farthest date to which he permitted his imagination to carry him, that, in relation to it, the historical period, even of Egypt, sinks into insignificance.

However, we moderns need not stop at the time when the delta was a gulf of the sea. The limestone rocks in which it is excavated and which extend east, west, and south for hundreds of miles, are full of the remains of marine animals, and belong, the latest to the eocene, the oldest to the cretaceous formation. The miocene gulf of the delta was, in fact, only the remains of the wide ocean which formerly extended from Hindostan to Morocco; and at the bottom of which the

accumulation of the shells and skeletons of its denizens gave rise to the ooze, which has since hardened into chalk and nummulitic limestone. And it is quite certain that the whole of the area now occupied by Egypt, north of Esneh, and probably all that north of Assouan, was covered by tolerably deep sea during the cretaceous epoch. It is also certain that a great extent of dry land existed in South Africa at a much earlier period. How far it extended to the north is unknown, but it may well have covered the area now occupied by the great lakes and the basins of the White and Blue Niles. And it is quite possible that these rivers may have existed and may have poured their waters into the Northern Ocean, before the elevatory movement—possibly connected with the outpour of the huge granitic masses of the Arabian range and of Nubia—commenced, which caused the calcareous mud covering its bottom to become the dry land of what is now the southern moiety of Upper Egypt, some time toward the end of the cretaceous epoch. Middle and Northern Egypt remained under water during the eocene, and Northern Egypt during the commencement, at any rate, of the miocene epoch; so that the process of elevation seems to have taken effect from south to north at an extremely slow rate. The northward drainage of the equatorial catchment basin thus became cut off from the sea by a constantly increasing plain sloping to the north. And, as the plain gradually rose, the stream, always flowing north, scooped the long valley of Nubia and of Egypt, and probably formed a succession of deltas which have long since been washed away. At last, probably in the middle, or the later part, of the miocene epoch, the elevatory movement came to an end, and the gulf of the delta began to be slowly and steadily filled up with its comparatively modern alluvium.

Thus, paradoxical as the proposition may sound, the Nile is not only older than its gift, the alluvial soil of Egypt, but it may be vastly older than the whole land of Egypt; and the river has shaped the casket in which the gift lies out of materials laid by the sea at its feet in the days of its youth.

The fourth problem of Herodotus—the origin and the antiquity of the Egyptian people—is much more difficult than the other three, and I can not deal with it at the end of a discourse which has already extended to an undue length.

But I may indicate a few cardinal facts which bear on the discussion.

According to Figari Bey's investigations, a marine deposit, which probably is of the same age as the miocene beaches of Cairo and Memphis, forms the floor of the delta. Above this, come the layers of sand with gravel already mentioned, as evidencing a former swifter flow of the river: then follow beds of mud and sand; and only above these, at three distinct levels, evidences of human handiwork, the last and latest of which belong to the age of Ramses II.

It is eminently desirable that these statements should be verified, for the doubts which have been thrown, to some extent justly, upon various attempts to judge the age of the alluvium of the Nile do not affect the proof of the relative antiquity of the human occupation of Egypt, which such facts would afford; and it is useless to speculate on the antiquity of the Egyptian race, or the condition of the delta when men began to people it, until they are accurately investigated.

As to the ethnological relations of the Egyptian race, I think all that can be said is, that neither the physical nor the philological evidence, as it stands, is very satisfactory. That the Egyptians are not negroes is certain, and that they are totally different from any typical Semites is also certain. I am not aware that there are any people who resemble them in character of hair and complexion, except the Dravidian tribes of Central India, and the Australians; and I have long been inclined to think, on purely physical grounds, that the latter are the lowest and the Egyptians the highest members of a race of mankind of great antiquity, distinct alike from Aryan and Turanian on the one side, and from negro and negrito on the other. And it seems to me that the philologists, with their "Cushites" and "Hamites," are tending toward a similar differentiation of the Egyptian stock from its neighbors. But, both on the anthropological and on the philological sides, the satisfactorily ascertained facts are few and the difficulties multitudinous.

I have addressed you to-night in my private capacity of a student of nature, believing, as I hope with justice, that the discussion of questions which have long attracted me would interest you. But I have not forgotten, and I dare say you have not, that I have the honor to stand in a very close official relation to Eton as a member of the Governing Body. And I have reason to think that, in some quarters, I am regarded as a dangerous member of that body, who, if he were not restrained by his colleagues, would endeavor to abolish the traditional studies of the school, and set the sixth form working at the generation of gases and the dissection of crawfishes, to the exclusion of your time-honored discipline in Greek and Latin.

To put the matter very gently, that statement is unhistorical; and I selected my topic for the discourse which I have just concluded, in order that I might show you, by an example, the outside limits to which my scientific fanaticism would carry me, if it had full swing. Before the fall of the second empire, the French liberals raised a cry for "Liberty as in Austria." I ask for "Scientific Education as in Halicarnassus," and that the culture given at Eton shall be, at any rate, no narrower than that of a Greek gentleman of the age of Pericles.

Herodotus was not a man of science, in the ordinary sense of the word; but he was familiar with the general results obtained by the "physiologists" of his day, and was competent to apply his knowledge

rationally. If he had lived now, a corresponding education would certainly have put him in possession of the very simple facts which I have placed before you; and the application to them of his own methods of reasoning would have taken him as far as we have been able to go. But, thirty years ago, Herodotus could not have obtained as much knowledge of physical science as he picked up at Halicarnassus in any English public school.

Long before I had anything to do with the affairs of Eton, however, the Governing Body had provided the means of giving such instruction in physical science as it is needful for every decently-educated Englishman to possess. I hear that my name is sometimes peculiarly connected (in the genitive case) with certain new laboratories; and, if it is to go down to posterity at all, I would as soon it went in that association as any other, whether I have any claim to the left-handed compliment or not. But you must recollect that nothing which has been done, or is likely to be done, by the Governing Body, is the doing of this or that individual member; or has any other end than the deepening and widening of the scheme of Eton education, until, without parting with anything ancient that is of perennial value, it adds all that modern training which is indispensable to a comprehension of the conditions of modern life.—*Macmillan's Magazine.*

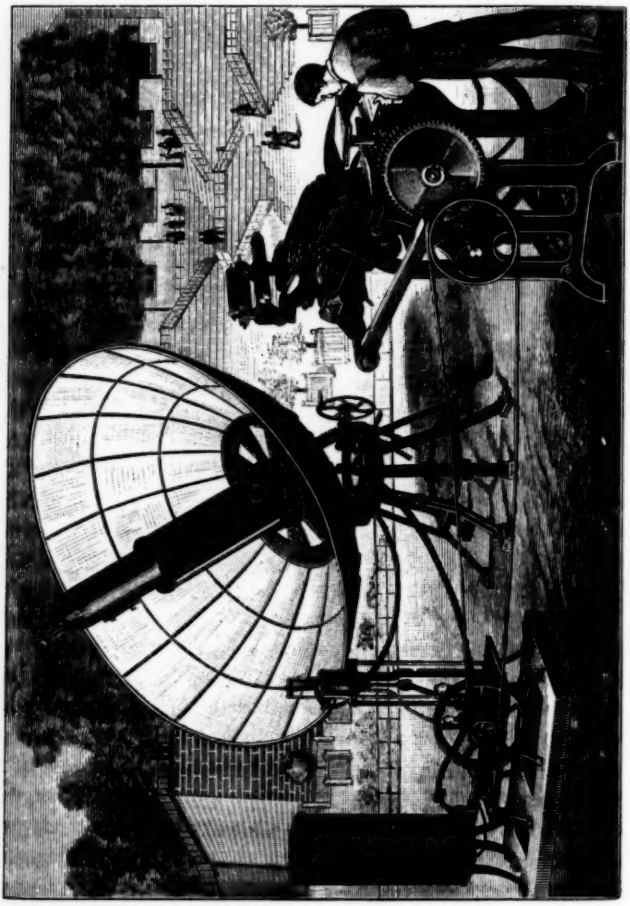
MACHINES DRIVEN BY SOLAR RAYS.

By GASTON TISSANDIER.

OUR readers have already been informed* respecting the solar machines constructed by MM. Mouchot and Abel Pifre, in which the heat of the sun is employed, either directly or through the agency of steam generated directly by it, as the source of power, and of their successful application to certain purposes in Algeria. M. Pifre, who is an assistant to M. Mouchot in his engineering work in Algeria, has continued his experiments, and made some improvements in the machines, by which their operation has been rendered more effective. The principal improvement is in the form of the reflector, or insolator, by means of which the rays of the sun are concentrated upon the boiler or other object to be heated. M. Mouchot's reflector was in the form of a simple hollow cone, formed with a straight line of projection. M. Pifre bends the line of projection so as to give it three different inclinations, and thereby obtains for the surface of his mirror a form nearly like that of a paraboloid. An interesting experiment upon the possibility of adapting the apparatus of M. Pifre to a European sun

* "Popular Science Monthly," vol. xviii, p. 283, and vol. xviii, p. 432.

was made on the 6th of August last, in the Garden of the Tuileries, Paris, on the occasion of the festival of the *Union Française de la jeunnesse.* An insolator, the reflector of which had an extreme diameter of three and a half metres, or nearly twelve feet, was set up near the steps of the Jeu de Paume. The steam generated in the boiler, which was placed in the focus of the mirror, was applied to a small



PRINTING A NEWSPAPER BY SOLAR HEAT.
Experiment by M. Abel Pifre in the Garden of the Tuileries, Paris, August 6, 1882.

vertical engine of thirty kilogrammetres power, and this was connected with a Maroni press. Although the sun was not very hot, and the radiation was interrupted by frequent clouds, the press was kept in regular operation from one o'clock in the afternoon till half-past five, printing on an average five hundred copies an hour of a journal specially prepared for the occasion, and called "Soleil-Journal" (Sun-Journal). This little experiment is not likely just yet to produce a revolution in the art of printing, but its success may enable us to judge, in some degree, how useful the insolators may be made in latitudes where

the solar radiation is more intense and more constant than in Paris. The engraving correctly represents the arrangement of the apparatus. M. Pifre's insolator is shown in the center, with its great parabolic mirror. The engine which it drove is shown by the side of it, while on the right and in the foreground may be seen the press printing the journal. We have a right to believe that heliodynamics may at some future time be usefully and profitably employed in hot countries.

THE GREAT BRIDGE AND ITS LESSONS.

ADDRESS BY ABRAM S. HEWITT.

TWO hundred and seventy years ago the good ship Tiger, commanded by Captain Adraien Block, was burned to the water's edge as she lay at anchor, just off the southern end of Manhattan Island. Her crew, thus forced into winter quarters, were the first white men who built and occupied a house on the land where New York now stands; "then," to quote the graphic language of Mrs. Lamb, in her history of the city, "in primeval solitude, waiting till commerce should come and claim its own. Nature wore a hardy countenance, as wild and as untamed as the savage landholders. Manhattan's twenty-two thousand acres of rock, lake, and rolling tableland, rising at places to a height of one hundred and thirty-eight feet, were covered with somber forests, grassy knolls, and dismal swamps. The trees were lofty, and old, decayed, and withered limbs contrasted with the younger growth of branches; and wild flowers wasted their sweetness among the dead leaves and uncut herbage at their roots. The wanton grape-vine swung carelessly from the topmost boughs of the oak and the sycamore; and blackberry and raspberry bushes, like a picket-guard, presented a bold front in all possible avenues of approach. The entire surface of the island was bold and granitic, and in profile resembled the cartilaginous back of the sturgeon." This primeval scene was the product of natural forces working through uncounted periods of time; the continent slowly rising and falling in the sea like the heaving breast of a world asleep; glaciers carving patiently through ages the deep estuaries; seasons innumerable clothing the hills with alternate bloom and decay.

The same sun shines to-day upon the same earth; yet how transformed! Could there be a more astounding exhibition of the power of man to change the face of Nature than the panoramic view which presents itself to the spectator standing upon the crowning arch of the bridge whose completion we are here to-day to celebrate in the honored presence of the President of the United States, with their fifty millions; of the Governor of the State of New York, with its five millions;

and of the mayors of the two cities, aggregating over two millions of inhabitants? In the place of stillness and solitude, the footsteps of these millions of human beings; instead of the smooth waters, "unvexed by any keel," highways of commerce ablaze with the flags of all nations; and where once was the green monotony of forested hills, the piled and towering splendors of a vast metropolis, the countless homes of industry, the echoing marts of trade, the gorgeous palaces of luxury, the silent and steadfast spires of worship!

To crown all, the work of separation wrought so surely, yet so slowly, by the hand of time, is now reversed in our own day, and "Manahattaa" and "Seawanhaka" are joined again as once they were before the dawn of life in the far azoic ages.

"It is done!
Clang of bell and roar of gun
Send the tidings up and down.
How the belfries rock and reel!
How the great guns, peal on peal,
Fling the joy from town to town!"

"What hath God wrought!" were the words of wonder which ushered into being the magnetic telegraph, the greatest marvel of the many marvelous inventions of the present century. It was the natural impulse of the pious maiden who chose this first message of reverence and awe, to look to the Divine Power as the author of a new gospel. For it was the invisible, and not the visible agency, which addressed itself to her perceptions. Neither the bare poles nor the slender wire, nor even the small battery, could suggest an adequate explanation for the extinction of time and space which was manifest to her senses, and she could only say, "What hath God wrought!"

But when we turn from the unsightly telegraph to the graceful structure at whose portal we stand, and when we contrast the airy outline of its curves of beauty, pendent between massive towers suggestive of art alone, with the overreaching vault of heaven above and the ever-moving flood of waters beneath, the work of Omnipotent Power, we are irresistibly moved to exclaim, "What hath *man* wrought!"

Man hath indeed wrought far more than strikes the eye in this daring undertaking, which, by the general judgment of engineers, stands to-day without a rival among the wonders of human skill. It is not the work of any one man or of any one age. It is the result of the study of the experience and of the knowledge of many men in many ages. It is not merely a creation; it is a growth. It stands before us to-day as the sum and epitome of human knowledge; as the very heir of the ages; as the latest glory of centuries of patient observation, profound study, and accumulated skill, gained, step by step, in the never-ending struggle of man to subdue the forces of Nature to his control and use.

In no previous period of the world's history could this bridge have been built. Within the last hundred years the greater part of the knowledge necessary for its erection has been gained. Chemistry was not born until 1776, the year when political economy was ushered into the world by Adam Smith, and the Declaration of Independence was proclaimed by the Continental Congress, to be maintained at the point of the sword by George Washington. In the same year Watt produced his successful steam-engine, and a century has not elapsed since the first specimen of his skill was erected on this continent. The law of gravitation was indeed known a hundred years ago, but the intricate laws of force which now control the domain of industry had not been developed by the study of physical science, and their practical applications have only been effectually accomplished within our own day, and, indeed, some of the most important of them during the building of the bridge. For use in the caissons, the perfecting of the electric light came too late, though happily in season for the illumination of the finished work.

This construction has not only employed every abstract conclusion and formula of mathematics, whether derived from the study of the earth or the heavens, but the whole structure may be said to rest upon a mathematical foundation. The great discoveries of chemistry, showing the composition of water, the nature of gases, the properties of metals, the laws and processes of physics, from the strains and pressures of mighty masses to the delicate vibrations of molecules, are all recorded here. Every department of human industry is represented, from the quarrying and the cutting of the stones, the mining and smelting of the ores, the conversion of iron into steel by the pneumatic process, to the final shaping of the masses of metal into useful forms, and its reduction into wire, so as to develop in the highest degree the tensile strength which fits it for the work of suspension. Every tool which the ingenuity of man has invented has somewhere, in some special detail, contributed its share in the accomplishment of the final result.

> "Ah! what a wondrous thing it is
> To note how many wheels of toil
> One word, one thought can set in motion!"

But without the most recent discoveries of science, which have enabled steel to be substituted for iron—applications made since the original plans of the bridge were devised—we should have had a structure fit, indeed, for use, but of such moderate capacity that we could not have justified the claim which we are now able to make, that the cities of New York and Brooklyn have constructed and to-day rejoice in the possession of the crowning glory of an age memorable for great industrial achievements.

This is not the proper occasion for describing the details of this undertaking. This grateful task will be performed by the engineer in

the final report, with which every great work is properly committed to the judgment of posterity. But there are some lessons to be drawn from the hasty considerations I have presented, which may encourage and comfort us as to the destiny of man and the outcome of human progress.

What message, then, of hope and cheer does this achievement convey to those who would fain believe that love travels hand in hand with light along the rugged pathway of time? Have the discoveries of science, the triumphs of art, and the progress of civilization, which have made its construction a possibility and a reality, promoted the welfare of mankind and raised the great mass of the people to a higher plane of life?

This question can best be answered by comparing the compensation of the labor employed in the building of this bridge with the earnings of labor employed upon works of equal magnitude in ages gone by. The money expended for the work of construction proper on the bridge, exclusive of land damages and other expenses, such as interest, not entering into actual cost, is nine million ($9,000,000) dollars. This money has been distributed in numberless channels—for quarrying, for mining, for smelting, for fabricating the metals, for shaping the materials, and erecting the work, employing every kind and form of human labor. The wages paid at the bridge itself may be taken as the fair standard of the wages paid for the work done elsewhere. These wages are:

				Average.
Laborers	$1 75			per day.
Blacksmiths	3 50	to	$4 00	"
Carpenters	3 00	to	3 50	"
Masons and stone-cutters	3 50	to	4 00	"
Riggers	2 00	to	2 50	"
Painters	2 00	to	3 50	"

Taking all these kinds of labor into account, the wages paid for work on the bridge will thus average $2.50 per day.

Now, if this work had been done at the time when the Pyramids were built, with the skill, appliances, and tools then in use, and if the money available for its execution had been limited to nine million ($9,000,000) dollars, the laborers employed would have received an average of not more than two cents per day, in money of the same purchasing power as the coin of the present era. In other words, the effect of the discoveries of new methods, tools, and laws of force, has been to raise the wages of labor more than a hundred-fold in the interval which has elapsed since the Pyramids were built. I shall not weaken the suggestive force of this statement by any comments upon the astounding evidence of progress, beyond the obvious corollary that such a state of civilization as gave birth to the Pyramids would now be the signal for universal bloodshed, revolution, and anarchy. I do not underestimate the hardships borne by the labor of this century.

They are, indeed, grievous, and to lighten them is, as it should be, the chief concern of statesmanship. But this comparison proves that through forty centuries these hardships have been steadily diminished; that all the achievements of science, all the discoveries of art, all the inventions of genius, all the progress of civilization, tend, by a higher and immutable law, to the steady and certain amelioration of the condition of society. It shows that, notwithstanding the apparent growth of great fortunes, due to an era of unparalleled development, the distribution of the fruits of labor is approaching, from age to age, to more equitable conditions, and must, at last, reach the plane of absolute justice between man and man.

But this is not the only lesson to be drawn from such a comparison. The Pyramids were built by the sacrifices of the living for the dead. They served no useful purpose, except to make odious to future generations the tyranny which reduces human beings into beasts of burden. In this age of the world such a waste of effort would not be tolerated. To-day the expenditures of communities are directed to useful purposes. Except only works designed for defense in time of war, the wealth of society is now mainly expended in opening channels of communication for the free play of commerce and the communion of the human race. An analysis of the distribution of the surplus earnings of man after providing food, shelter, and raiment, shows that they are chiefly absorbed by railways, canals, ships, bridges, and telegraphs. In ancient times these objects of expenditure were scarcely known. Our bridge is one of the most conspicuous examples of this change in the social condition of the world and of the feeling of men. In the middle ages, cities walled each other out, and the fetters of prejudice and tyranny held the energies of man in hopeless bondage. To-day men and nations seek for free intercourse with each other, and the whole force of the intellect and energy of the world is expended in breaking down the barriers, established by Nature or created by man, to the solidarity of the human race.

And yet in view of this tendency, the most striking and characteristic feature of the nineteenth century, there still are those who believe and teach that obstruction is the creator of wealth; that the peoples can be made great and free by the erection of artificial barriers to the beneficent action of commerce, and the unrestricted intercourse of men and nations with each other. If they are right, then this bridge is a gigantic blunder, and the doctrine which bids us to love our neighbors as ourselves is founded upon a misconception of the Divine purpose.

But the bridge is more than an embodiment of the scientific knowledge of physical laws, or a symbol of social tendencies. It is equally a monument to the moral qualities of the human soul. It could never have been built by mere knowledge and scientific skill alone. It required in addition the infinite patience and unwearied courage by which great results are achieved. It demanded the endurance of heat and

cold and physical distress. Its constructors have had to face death in its most repulsive form. Death, indeed, was the fate of its great projector, and dread disease the heritage of the greater engineer who has brought it to completion. The faith of the saint and the courage of the hero have been combined in the conception, the design, and the execution of this work.

Let us then record the names of the engineers and foremen who have thus made humanity itself their debtor, for the successful achievement which is not the result of accident or of chance, but is the fruit of design, and of the consecration of all personal interest to the public weal. They are: John A. Roebling, who conceived the project and formulated the plan of the bridge; Washington A. Roebling, who, inheriting his father's genius, and more than his father's knowledge and skill, has directed the execution of this great work from its inception to its completion; aided in the several departments by Charles C. Martin, Francis Collingwood, William H. Payne, George W. McNulty, Wilhelm Hilderbrand, Samuel R. Probasco, and E. F. Farrington, Arthur V. Abbott, William Van der Bosch, Charles Young, and Harry Tupple, who, in apparently subordinate positions, have shown themselves peculiarly fitted to command, because they have known how to serve. But the record would not be complete without reference to the unnamed men by whose unflinching courage, in the depths of the caissons, and upon the suspended wires, the work was carried on amid storms, and accidents, and dangers, sufficient to appall the stoutest heart. To them we can only render the tribute which history accords to those who fight as privates in the battles of freedom, with all the more devotion and patriotism because their names will never be known by the world whose benefactors they are. One name, however, which will find no place in the official records, can not be passed over here in silence. In ancient times when great works were constructed, a goddess was chosen, to whose tender care they were dedicated. Thus the ruins of the Acropolis to-day recall the name of Pallas Athene to an admiring world. In the middle ages the blessing of some saint was invoked to protect from the rude attacks of the barbarians and the destructive hand of time the building erected by man's devotion to the worship of God. So, with this bridge will ever be coupled the thought of one through the subtile alembic of whose brain, and by whose facile fingers, communication was maintained between the directing power of its construction and the obedient agencies of its execution. It is thus an everlasting monument to the self-sacrificing devotion of woman, and of her capacity for that higher education from which she has been too long debarred. The name of Mrs. Emily Warren Roebling will thus be inseparably associated with all that is admirable in human nature, and with all that is wonderful in the constructive world of art.

This tribute to the engineers, however, would not be deserved if there is to be found any evidence of deception on their part in the

origin of the work, or any complicity with fraud in its execution and completion. It is this consideration which induced me to accept the unexpected invitation of the trustees to speak for the city of New York on the present occasion. When they thus honored me, they did not know that John A. Roebling addressed to me the letter in which he first suggested (and, as far as I am aware, he was the first engineer to suggest) the feasibility of a bridge between the two cities, so constructed as to preserve unimpaired the freedom of navigation. This letter, dated June 19, 1857, I caused to be printed in the "Journal of Commerce," where it attracted great attention because it came from an engineer who had already demonstrated, by successfully building suspension bridges over the Schuylkill, the Ohio, and the Niagara Rivers, that he spoke with the voice of experience and authority. This letter was the first step toward the construction of the work, which, however, came about in a manner different from his expectations, and was finally completed on a plan more extensive than he had ventured to describe. It has been charged that the original estimates of cost have been far exceeded by the actual outlay. If this were true, the words of praise which I have uttered for the engineers who designed and executed this work ought rather to have been a sentence of censure and condemnation. Hence the invitation, which came to me unsought, seemed rather to be an appeal from the grave for such vindication as it was within my power to make, and which could not come with equal force from any other quarter.

Engineers are of two kinds—the creative and the constructive. The power to conceive great works demands imagination and faith. The creative engineer, like the poet, is born, not made. If to the power to conceive is added the ability to execute, then have we one of those rare geniuses who not only benefit the world but add new glory to humanity. Such men were Michael Angelo, Leonardo da Vinci, Watt, Wedgwood, Brunel, and Stephenson; and such a man was John A. Roebling. It was his striking peculiarity that, while his conceptions were bold and original, his execution was always exact and within the limits of cost which he assigned to the work of his brain. He had made bridges a study, and had declared in favor of the suspension principle for heavy traffic, when the greatest living authorities had condemned it as costly and unsafe. When he undertook to build a suspension-bridge for railway use, he did so in the face of the deliberate judgment of the profession, that success would be impossible. George Stephenson had condemned the suspension principle and approved the tubular girder for railway traffic. But it was the Nemesis of Stephenson's fate that, when he came out to approve the location of the great tubular bridge at Montreal, he should pass over the Niagara River in a railway-train, on a suspension-bridge, which he had declared to be an impracticable undertaking.

When Roebling suggested the bridge over the East River, his ideas

were limited to the demands of the time, and controlled by the necessity for a profitable investment. He had no expectation that the two cities would embark in the enterprise. Indeed, in one of his letters so late as April 14, 1860, he says, "As to the corporations of New York and Brooklyn undertaking the job, no such hope may be entertained in our time." In eight years thereafter, these cities had undertaken the task upon a scale of expense far exceeding his original ideas of a structure to be built exclusively by private capital for the sake of profit.

How came this miracle to pass? The war of the rebellion occurred, delaying for a time the further consideration of Roebling's ideas. This war accustomed the nation to expenditures on a scale of which it had no previous conception. It did more than expend large sums of money. Officials became corrupt, and organized themselves for plunder. In the city of New York especially, the government fell into the hands of a band of thieves, who engaged in a series of great and beneficial public works, not for the good they might do, but for the opportunity which they would afford to rob the public treasury. They erected court-houses and armories; they opened roads, boulevards, and parks; and they organized two of the grandest devices for transportation which the genius of man has ever conceived: a rapid-transit railway for New York, and a great highway between New York and Brooklyn. The bridge was commenced, but the ring was driven into exile by the force of public indignation, before the rapid-transit scheme, since executed on a different route by private capital, was undertaken. The collapse of the ring brought the work on the bridge to a stand-still.

It was a timely event. The patriotic New-Yorker might well have exclaimed, just before this great deliverance, in the words of the consul of ancient Rome, in Macaulay's stirring poem:

> "And if they once may win the bridge,
> What hope to save the town?"

Meanwhile, the elder Roebling had died, leaving behind him his estimates and the general plans of the structure, to cost, independent of land damages and interest, about $7,000,000. This great work, which, if not "conceived in sin," was "brought forth in iniquity," thus became the object of great suspicion, and of a prejudice which has not been removed to this day. I know that to many I make a startling announcement when I state the incontrovertible fact that no money was ever stolen by the ring from the funds of the bridge; that the whole money raised has been honestly expended; that the estimates for construction have not been materially exceeded, and that the excess of cost over the estimates is due to purchases of land which were never included in the estimates, to interest paid on the city subscriptions, and to the cost of additional height and breadth of the

bridge and the increase in strength rendered necessary by a better comprehension of the volume of traffic between the two cities. The items covered by the original estimate of $7,000,000 have thus been raised to $9,000,000, so that $2,000,000 represents the addition to the original estimates, and for this excess, amounting to less than thirty per cent, there is actual value in the bridge in increased dimensions and strength, whereby its capacity has been greatly increased.

The carriage-ways, as originally designed, would have permitted only a single line of vehicles in each direction. The speed of the entire procession, more than a mile long, would therefore have been limited by the rate of the slowest; and every accident causing stoppage to a single cart would have stopped everything behind it for an indefinite period. It is not too much to say that the removal of this objection, by widening the carriage-ways, has multiplied manifold the practical usefulness of the bridge.

The statement I have made is due to the memory not only of John A. Roebling, but also of Henry C. Murphy, that great man, who devoted his last years to this enterprise; and who, having, like Moses, led the people through the toilsome way, was permitted only to look, but not to enter, upon the promised land.

This testimony is due also to the living trustees, and to the engineers who have controlled and directed this large expenditure in the public service—the latter, in the conscientious discharge of professional duty; and the former, with no other object than the welfare of the public, and without any other possible reward than the good opinion of their fellow-citizens.

I do not make this statement without a full sense of the responsibility which it involves, and I realize that its accuracy will shortly be tested by the report of experts who are now examining the accounts. But it will be found that I have spoken the words of truth and soberness. When the ring absconded, I was asked by William C. Havemeyer, then the Mayor of New York, to become a trustee, in order to investigate the expenditures, and to report as to the propriety of going on with the work. This duty was performed without fear or favor. The methods by which the ring proposed to benefit themselves were clear enough, but its members fled before they succeeded in reimbursing themselves for the preliminary expenses which they had defrayed. With their flight a new era commenced, and, during the three years when I acted as a trustee, I am sure that no fraud was committed, and that none was possible. Since that date the board has been controlled by trustees, some of whom are thorough experts in bridge-building, and the others men of such high character that the suggestion of malpractice is improbable to absurdity.

The bridge has not only been honestly built, but it may be safely asserted that it could not now be duplicated at the same cost. Much money might, however, have been saved if the work had not been

delayed through want of means, and unnecessary obstacles interposed by mistaken public officials. Moreover, measured by its capacity, and the limitations imposed on its construction by its relation to the interests of traffic and navigation, it is the cheapest structure ever erected by the genius of man. This will be made evident by a single comparison with the Britannia Tubular Bridge, erected by Stephenson over the Menai Strait. He adopted the tubular principle because he believed that the suspension principle could not be made practical for railway-traffic, although he had to deal with spans not greater than 470 feet. He built a structure that contained 10,540 tons of iron, and cost £601,000, or about $3,000,000. Fortunately, he has left a calculation on record as to the possible extension of the tubular girder, showing that it would reach the limits in which it could bear only its own weight (62,000 tons) at 1,570 feet. Now, for a span of 1,600 feet, the Brooklyn Bridge contains but 6,740 tons of material, and will sustain seven times its own weight. Its cost is $9,000,000, whereas a tubular bridge for the same span would contain ten times the weight of the metal, and, though costing twice as much money, would be without the ability to do any useful work.

Roebling, therefore, solved the problem which had defied Stephenson, and upon his design has been built a successful structure at half the cost of a tubular bridge that would have fallen when loaded in actual use. It is impossible to furnish any more striking proof of the genius which originated and of the economy which constructed this triumph of American engineering.

We have thus a monument to the public spirit of the two cities, created by an expenditure as honest and as economical as those which gave us the Erie Canal, the Croton Aqueduct, and the Central Park. If it had been otherwise, it would have been a monument to the eternal infamy of the trustees and of the engineers under whose supervision it has been erected; and this brings me to the final consideration which I feel constrained to offer on this point.

During all these years of trial and false report a great soul lay in the shadow of death, praying only to stay long enough for the completion of the work to which he had devoted his life. I say a great soul, for in the spring-time of youth, with friends and fortune at his command, he gave himself to his country, and for her sake braved death on many a well-fought battle-field. When restored to civil life, his health was sacrificed to the duties which had devolved upon him as the inheritor of his father's fame and the executor of his father's plans. Living only for honor, and freed from the temptations of narrow means, how is it conceivable that such a man—whose approval was necessary to every expenditure—should, by conniving with jobbers, throw away more than the life which was dear to him that he might fulfill his destiny and leave to his children the heritage of a good name and the glory of a grand achievement? Well might this

suffering hero quote the words of "Hyperion": "Oh, I have looked with wonder upon those who, in sorrow and privation, and bodily discomfort, and sickness, which is the shadow of death, have worked right on to the accomplishment of their great purposes; toiling much, enduring much, fulfilling much; and then, with shattered nerves and sinews all unstrung, have laid themselves down in the grave and slept the sleep of death, and the world talks of them while they sleep! And as in the sun's eclipse we can behold the great stars shining in the heavens, so in this life-eclipse have these men beheld the lights of the great eternity, burning solemnly and forever!"

And now what is to be the outcome of this great expenditure upon the highway which has been constructed between the two cities, for which Dr. Storrs and I have the honor to speak to-day? That Brooklyn will gain in numbers and in wealth with accelerated speed is a foregone conclusion. Whether this gain shall in any wise be at the expense of New York is a matter in regard to which the great metropolis does not concern herself. Her citizens are content with the knowledge that she exists and grows with the growth of the whole country, of whose progress and prosperity she is but the exponent and the index. Will the bridge lead, as has been forcibly suggested, and in some quarters hopefully anticipated, to the union of the two cities under one name and one government? This suggestion is in part sentimental and in part practical. So far as the union in name is concerned, it is scarcely worth consideration, for in any comparison which our national or local pride may institute between this metropolis and the other great cities of the world, its environment, whether in Long Island, Staten Island, or New Jersey, will always be included. In considering the population of London, no one ever separates the city proper from the surrounding parts. They are properly regarded as one homogeneous aggregation of human beings.

It is only when we come to consider the problem of governing great masses that the serious elements of the question present themselves, and must be determined before a satisfactory answer can be given. The tendency of modern civilization is toward the concentration of population in dense masses. This is due to the higher and more diversified life which can be secured by association and co-operation on a large scale, affording not merely greater comfort and often luxury, but actually distributing the fruits of labor on a more equitable basis than is possible in sparsely settled regions and among feeble communities. The great improvements of our day in labor-saving machinery and its application to agriculture enable the nation to be fed with a less percentage of its total force thus applied, and leave a larger margin of population free to engage in such other pursuits as are best carried on in large cities.

The disclosures of the last census prove the truth of this statement. At the first census in 1790 the population resident in cities was 3·3 per

cent of the total population. This percentage slowly gained at each successive census, until in 1840 it had reached 8·5 per cent. In fifty years it had thus gained a little over 5 per cent. But in 1850 it rose to 12·5 per cent, in 1860 it was 16·1 per cent; in 1870 it was 20·9 per cent, having in this one decade gained as much as in the first fifty years of our political existence. In 1880 the population resident in cities was 22·5 per cent of the whole population.

Contemporaneous with this rapid growth of urban population have grown the complaints of corrupt administration and bad municipal government. The outcry may be said to be universal, for it comes from both sides of the Atlantic; and the complaints appear to be in direct proportion to the size of cities. It is obvious, therefore, that the knowledge of the art of local government has not kept pace with the growth of population. I am here by your favor to speak for the city of New York, and I should be the last person to throw any discredit on its fair fame; but I think I only give voice to the general feeling when I say that the citizens of New York are satisfied neither with the structure of its government nor with its actual administration, even when it is in the hands of intelligent and honest officials. Dissatisfied as we are, no man has been able to devise a system which commends itself to the general approval, and it may be asserted that the remedy is not to be found in devices for any special machinery of government. Experiments without number have been tried, and suggestions in infinite variety have been offered, but to-day no man can say that we have approached any nearer to the idea of good government which is demanded by the intelligence and the wants of the community.

If, therefore, New York has not yet learned to govern itself, how can it be expected to be better governed by adding half a million to its population and a great territory to its area, unless it be with the idea that a "little leaven leaveneth the whole lump"? Is Brooklyn that leaven? And if not, and if possibly "the salt has lost its savor, wherewith shall it be salted?" Brooklyn is now struggling with this problem—it remains to be seen with what success; but meanwhile it is idle to consider the idea of getting rid of our common evils by adding them together.

Besides, it is a fundamental axiom in politics, approved by the experience of older countries as well as of our own, that the sources of power should never be far removed from those who are to feel its exercise. It is the violation of this principle which produces chronic revolution in France, and makes the British rule so obnoxious to the Irish people. This evil is happily avoided when a natural boundary circumscribes administration within narrow limits. While, therefore, we rejoice together at the new bond between New York and Brooklin, we ought to rejoice the more that it destroys none of the conditions which permit each city to govern itself, but rather urges them

to a generous rivalry in perfecting each its own government, recognizing the truth that there is no true liberty without law, and that eternal vigilance, which is the only safeguard of liberty, can best be exercised within limited areas.

It would be a most fortunate conclusion if the completion of this bridge should arouse public attention to the absolute necessity of good municipal government, and recall the only principle upon which it can ever be successfully founded. There is reason to hope that this result will follow, because the erection of this structure shows how a problem, analogous to that which confronts us in regard to the city government, has been met and solved in the domain of physical science.

The men who controlled this enterprise at the outset were not all of the best type ; some of them, as we have seen, were public jobbers. But they knew that they could not build a bridge, although they had no doubt of their ability to govern a city. They thereupon proceeded to organize the knowledge which existed as to the construction of bridges, and they held the organization thus created responsible for results. Now, we know that it is at least as difficult to govern a city as to build a bridge, and yet, as citizens, we have deliberately allowed the ignorance of the community to be organized for its government, and we then complain that it is a failure. Until we imitate the example of the ring, and organize the intelligence of the community for its government, our complaint is childish and unreasonable. But we shall be told that there is no analogy between building a bridge and governing a city. Let us examine this objection. A city is made up of infinite interests. They vary from hour to hour, and conflict is the law of their being. Many of the elements of social life are what mathematicians term " variables of the independent order." The problem is to reconcile these conflicting interests and variable elements into one organization which shall work without jar, and allow each citizen to pursue his calling, if it be an honest one, in peace and quiet.

Now, turn to the bridge. It looks like a motionless mass of masonry and metal ; but, as a matter of fact, it is instinct with motion. There is not a particle of matter in it which is at rest even for the minutest portion of time. It is an aggregation of unstable elements, changing with every change in the temperature and every movement of the heavenly bodies. The problem was, out of these unstable elements to produce absolute stability ; and it was this problem which the engineers, the organized intelligence, had to solve, or confess to inglorious failure. The problem has been solved. In the first construction of suspension-bridges it was attempted to check, repress, and overcome their motion, and failure resulted. It was then seen that motion is the law of existence for suspension-bridges, and provision was made for its free play. Then they became a success. The bridge before us elongates and contracts between the extremes of temperature from fourteen to sixteen inches ; the vertical rise and fall in the center of

the main span ranges between two feet three inches and two feet nine inches; and before the suspenders were attached to the cable it actually revolved on its own axis through an arc of thirty degrees, when exposed to the sun shining upon it on one side. You do not perceive this motion, and you would know nothing about it unless you watched the gauges which record its movement.

Now, if our political system were guided by organized intelligence, it would not seek to repress the free play of human interests and emotions, of human hopes and fears, but would make provision for their development and exercise, in accordance with the higher law of liberty and morality. A large portion of our vices and crimes are created either by law or its maladministration. These laws exist because organized ignorance, like a highwayman with a club, is permitted to stand in the way of wise legislation and honest administration, and to demand satisfaction from the spoils of office and the profits of contracts. Of this state of affairs we complain, and on great occasions the community arises in its wrath and visits summary punishment on the offenders of the hour, and then relapses into chronic grumbling until grievances sufficiently accumulate to stir it again to action.

What is the remedy for this state of affairs? Shall there be no more political parties, and shall we shatter the political machinery which, bad as it is, is far better than no machinery at all? Shall we embrace nihilism as our creed, because we have practical communism forced upon us as the consequence of jobbery and the imposition of unjust taxes?

No, let us rather learn the lesson of the bridge. Instead of attempting to restrict suffrage, let us try to educate the voters; instead of disbanding parties, let each citizen within the party always vote, but never for a man who is unfit to hold office. Thus parties, as well as voters, will be organized on the basis of intelligence.

But what man is fit to hold office? Only he who regards political office as a public trust, and not as a private perquisite to be used for the pecuniary advantage of himself, or his family, or even his party. Is there intelligence enough in these cities, if thus organized within the parties, to produce the result which we desire? Why, the overthrow of the Tweed ring was conclusive evidence of the preponderance of public virtue in the city of New York. In no other country in the world, and in no other political system than one which provides for and secures universal suffrage, would such a sudden and peaceful revolution have been possible. The demonstration of this fact was richly worth the twenty-five or thirty millions of dollars which the thieves had stolen. Thereafter and thenceforth there was no doubt whether our city population, heterogeneous as it is, contains within itself sufficient virtue for its own preservation. Let it never be forgotten that the remedy is complete, that it is ever present, that no man ought to be deprived of the opportunity of its exercise, and that,

if it be exercised, the will of the community can never be paralyzed. Our safety and our success rest on the ballot in the hands of freemen at the polls, deliberately deposited, never for an unworthy man, but always with a profound sense of the responsibility which should govern every citizen in the exercise of this fundamental right.

If the lesson of the bridge, which I have thus sought to enforce, shall revive the confidence of the people in their own power, and induce them to use it practically for the election of good men to office, then indeed will its completion be a public blessing worthy of the new era of industrial development in which it is our fortunate lot to live.

Great indeed has been our national progress. Perhaps we, who belong to a commercial community, do not fully realize its significance and promise. We buy and sell stocks, without stopping to think that they represent the most astonishing achievements of enterprise and skill in the magical extension of our vast railway system; we speculate in wheat, without reflecting on the stupendous fact that the plains of Dakota and California are feeding hungry mouths in Europe; we hear that the Treasury has made a call for bonds, and forget that the rapid extinction of our national debt is a proof of our prosperity and patriotism, as wonderful to the world as was the power we exhibited in the struggle which left that apparently crushing burden upon us. If, then, we deal successfully with the evils which threaten our political life, who can venture to predict the limits of our future wealth and glory—wealth that shall enrich all; glory that shall be no selfish heritage, but the blessing of mankind? Beyond all legends of Oriental treasure, beyond all dreams of the golden age, will be the splendor, and majesty, and happiness of the free people dwelling upon this fair domain, if, as may be fairly anticipated, they shall then have learned how to make equitable distribution among themselves of the fruits of their common labor. As our own Bryant sang as long ago as 1821:

> "Here the free spirit of mankind at length
> Throws its last fetters off; and who shall place
> A limit to the giant's untamed strength,
> Or curb its swiftness in the forward race!
> Far, like the comet's way, through infinite space,
> Stretches the long, untraveled path of light
> Into the depths of ages; we may trace
> Distant, the brightening glory of its flight,
> Till the receding rays are lost to human sight."

At the ocean gateway of such a nation, well may stand the stately figure of "Liberty enlightening the World"; and, in hope and faith, as well as gratitude, we write upon the towers of our beautiful bridge, to be illuminated by her electric ray, the words of exultation, *Finis coronat opus.*

SELECTION IN GRAIN-GROWING.

By JAMES CHEESMAN.

THE principle of selection has long been appreciated by stock-breeders, and they have largely profited by the application of its teachings. As applied to the growth of cereals it has not found a very wide acceptance, not having had time to force itself on the attention of the average farmer. The founder of the practice of selecting grain for seed is Major Hallett, F. L. S., Brighton, England. In 1861 he planted ten grains of wheat, from a variety known there as Bellevue Talavera wheat, which up to that time had been sown as a spring wheat, and was declared to be quite incapable of withstanding the frost of winter. Nine of the ten plants from these grains were killed by the severe frost, but the other plant, although from the same ear, remained as healthy and vigorous as any of the winter varieties of wheat by their side. From this surviving plant seed has been selected and grown year after year as a winter wheat. Close observation shows that in the cereals, as throughout nature, no two plants or grains are exactly alike in productive power, and hence that of any two or greater number of grains or plants one is always superior to all the others, although the superiority can only be ascertained by actual field tests. It may consist in several particular characteristics, as power to withstand frost; prolificness; size and character of ear; size, form, quality and weight of grain; length and stiffness of straw; powers of tillering; rapidity of growth; and many others.

Throughout continued observations and experiments, extending over twenty years, the grower has found only three instances recorded in which there were two ears on a plant containing an equal number of grains, and one of these related to the Bellevue Talavera wheat, which must be considered quite exceptional as to variation. In both the other instances there was only a low stage of development, the equally finest two ears of each plant containing but 59 and 49 respectively. In every case where the plant presented an ear containing 60 grains and upward the next best ear was of less contents than the finest one. In twenty such instances taken consecutively and without omission, and referring to seven varieties of wheat, the average difference between the contents of the first and second ears was seven and a half grains. The difference in four of these instances was only one grain, but in other four it amounted to from seventeen to nineteen grains. The superior productive power of a grain over that of another may consist in a greater number of ears upon the plants it produces, or in their individually containing a greater number of grains.

During these investigations no single circumstance more forcibly illustrated the necessity for repeated selection than the fact that, of the grains in the same ear, one is found to excel greatly all the others in vital power, as in the case of the Bellevue Talavera. The original two ears together contained 87 grains ; these were all planted singly. One of them produced ten ears containing 688 grains, and not only could the produce of no other single grain compare with them, but the finest ten ears which could be collected from the produce of the whole of the other 86 grains contained only 598 ; yet supposing that this superior grain grew in the smaller of the two original ears, and that this contained but 40 grains, there must still have been 39 of these 86 grains which grew in the same ear. So far as regards *contents* of ears.

The next year the grains from the largest ear of the finest plant of the previous year were planted singly, twelve inches apart, in a continuous row ; one of them produced a plant consisting of fifty-two ears ; those next to and on either side of it of twenty-nine and seventeen ears respectively ; and the finest of all the other plants consisted of only forty ears.

The following are the *chief* points of the standard in the order of their importance, but all have to be duly considered :

1. Hardihood of constitution.
2. Trueness of type.
3. Quality of sample.
4. Productiveness.
5. Power of tillering.
6. Stiffness and toughness of straw.
7. Earliness of ripening.

The system of selection here pursued is as follows : A grain produces a plant, consisting of many ears. Then are planted the grains from these ears in such a manner that each ear occupies a row by itself, each of its grains occupying a hole in this row, the holes being twelve inches apart every way. At harvest, after the most careful study and comparison of the plants from all these grains, the finest one is selected, which is proof that its parent-grain was the best of all, under the peculiar circumstances of that season. This process is repeated annually, starting every year with the *proved* best grain, although the verification of this superiority is not obtained until the following harvest.

The subjoined statement will illustrate this system of selection, as the facts given are due to its influence alone : the kind of seed, the land, and the system of culture employed were precisely the same for every plant for four consecutive years ; neither was any manure used, nor any artificial means of fostering the plants resorted to.

The following table shows the character of each additional generation of selection :

YEAR.	EARS SELECTED.	Height.	Containing grains.	Number of ears on finest stool.
		Inches.		
1857	Original ear	4⅜	47	..
1858	Finest ear	6½	79	10
1859	Finest ear	7¾	91	22
1860	*Ears imperfect from wet season*	..	..	39
1861	Finest ear	8¾	123	52

Thus, by means of repeated selection *alone*, the length of the ears has been doubled, their *contents* nearly trebled, and the "tillering" power of the seed increased fivefold.

The following table gives similar increased contents of ear obtained in three other varieties of wheat :

Grains in original ear.	KIND OF WHEAT.	Grains in improved ear.
45	Original Red commenced in 1857	123
60	Hunter's White commenced in 1861	124
60	Victoria White commenced in 1862	114
32	Golden Drop commenced in 1864	96

It was supposed by ancient writers that the powers of grains differed in relation to their positions in the ear. This Major Hallett investigated in 1858, by planting the grains of ten ears on a plan showing their several positions in the ear. The only general result, among most conflicting ones, was that the smallest grains, those most remote from the center of growth, exhibited throughout, most unexpectedly, a vigor equal to that of the largest ; and that the remarked worst grains, in one or two instances, did not by any means fall so far short of the good ones as had been expected. Frequent trials have also been made of the comparative power of large and small, plump and thin grains, and, in the case of oats, which produce a small grain attached to a large one, trials as to their respective powers—with uniform results, viz., that, in good grains of the same pedigree, neither mere size nor situation in the ear supplies any indication of the superior grain.

Very close observation during many years led to the discovery that the variations in the cereals which Nature presents to us are not only hereditary, but that they proceed upon a fixed principle, and from them has been educed the following law of development of cereals :

1. Every fully-developed plant, whether of wheat, oats, or barley, presents an ear superior in productive power to any of the rest on that plant.

2. Every such plant contains one grain which, upon trial, proves more productive than any other.

3. The best grain in a given plant is found in its best ear.

4. The superior vigor of this grain is transmissible in different degrees to its progeny.

5. By repeated careful selection the superiority is accumulated.

6. The improvement, which is at first rapid, gradually, after a long series of years, is diminished in amount, and eventually so far arrested that practically a limit to improvement in the desired quality is reached.

7. By still continuing to select, the improvement is maintained, and *practically* a fixed type is the result.

THIN SEEDING WITH SELECTION.—Let us discuss what is possible by a combination of thin seeding with selection. In order to do this, we must look at the present modes of cultivating the cereals. Confining ourselves for the moment to wheat alone, we know that from two to five bushels per acre are sown. The bushel of ordinary wheat contains 700,000 grains and more, and, taking two bushels per acre as the quantity sown, we have about 1,500,000 grains per acre. Major Hallett has counted at harvest the number of ears upon a quarter of an acre of wheat (drilled 20th of November with one and a half bushel of seed per acre, and which proved an exceptionally heavy crop of fifty-six bushels per acre), and the number of ears found was 934,120 per acre, or not so many ears as the grains sown. Here it is evident, from the number of grains sown, that either the natural powers of tillering could not have been exercised, or that the greater part of the seed must have been sown uselessly. Doubtless some of the grains did produce more than one ear, but this only makes the case still worse for the remainder. Not only was the number of ears below that of the grains sown, but each ear was but the stunted survivor of a struggle for existence. A high authority has said that, if a square yard of thickly-sown wheat be counted in spring, and the supposed number of ears then recorded, it would be found that ninety per cent of them would be found missing at harvest. Beyond all question, in thickly-sown wheat, very many of what appear as stems in the spring die away before harvest, and have thus grown not only uselessly, but in the struggle for existence have *starved and stunted those which ultimately came to ears.*

In ordinary English crops the number of ears produced per acre being taken as about 1,000,000, and the crop as 34 bushels, we have, at 700,000 grains per bushel, 23,800,000 grains per acre, or an average per ear of only 23 to 24 grains; and, if more than 1,000,000 ears per acre be claimed, it must be at the expense of their contents. Five imperial pints (= 6·1 American measure) of wheat per acre planted in September, 12 inches × 12 inches, gave 1,001,880 ears per acre, or 67,760 ears in excess of those produced on the other side of the hedge from 1½ bushel, or *more than thirteen times the seed.* Again, 6·1 pints (American measure) of wheat planted 12 inches × 12 inches, October 17th, gave 958,320 ears per acre; and planted similarly, October 4th,

966,792 per acre; while one bushel, planted October 15th, gave only 812,160.

Two plants of 24 ears each gave 1,911 and 1,878 grains, or 79 per ear; 20 ears per foot, at 48 grains only per ear, would produce 88 bushels per acre. All the conditions of time and space being fulfilled, we can obtain from a *single parent-grain* as many ears as are ordinarily obtained from *twenty grains*, with this most important advantage, viz.: these ears being produced from plants which have attained (or nearly so) perfect development of their growth, contain more than double the common number of grains, and their contents may be largely increased by the continued annual selection of the most vigorous parent-grains. These small quantities may be drilled on a large scale in the following manner: The object is to insure perfect *singleness* and regularity of plant, with uniformity of depth. The two latter may be obtained by the drill, as may the former also by adopting the following plan: The seed-cups ordinarily used in drilling wheat are so large that they deliver in *bunches* of grains, consisting of six or seven, which fall together within a very small area, from which a less produce will be obtained than if it had been occupied by a single grain. The additional grains are thus not only wasted, but are positively injurious. By using seed-cups which are only large enough to contain one grain at a time, *a stream of single grains* is delivered, and the desired object, viz., the depositing of *grains singly*, at once attained. The intervals *in* the rows will not be exactly uniform, but *they will be sufficiently so for all practical purposes.* The width of these intervals will, of course, depend on the speed with which the seed-barrel revolves, which can be regulated at will by adjusting the gear which drives it. By this mode of drilling, the advantage of the "broad-cast" system is obtained (equal distribution), as the rows may be close together, and the grains as thin *in* the rows as may be desired.

The crop should be hoed, as soon and as frequently as possible, with a horse-hoe. If the seed has been sown early, this should be done *in the autumn*, as it causes the plants to tiller and occupy the whole ground before winter sets in. It is essential to the success of thin seeding to keep the land perfectly free from weeds during the growth of the crop.

Now, what are the advantages of Major Hallett's system? A bushel of pedigree wheat (original red) produced from single grains, planted 12 inches × 12 inches, contains about 460,000 grains, while a bushel of ordinary wheat contains 700,000 or more grains. Therefore, in two crops consisting of exactly the same number of grains, the crop from thin seeding would be upward of 70 bushels against 46 bushels per acre. Again, a bushel of pedigree barley, produced from grains planted singly, contains 390,400 grains; while a bushel of ordinary barley contains upward of 550,000, or, in two crops of equal *numbers* of grains, the one would be 55 bushels, the other 39 bushels, per acre.

Thus in the increased size alone we get an increased crop of forty to fifty per cent.

The saving of seed from such a practice is immense. The wheat area of the United States is not less than 40,000,000 acres, and the average seeding is very much higher than two bushels per acre. But, if these figures be taken as a basis, we shall not err on the wrong side. To plant grain at the rate of one berry to each square foot would be equal to 43,560 grains per acre of 4,840 square yards, or less than two English quarts. This shows that the farmers of the United States have it in their power to reduce their consumption of seed-wheat from 80,000,000 bushels to 2,500,000. Good seed-wheat ought certainly to be worth a dollar a bushel out West, and is worth very much more in the East; but on this showing we have a possible saving of $77,500,000 in seed only for the wheat-crop alone. One dollar and a half per head of the population is worth attention.

The roots of wheat sown in August become by the middle of October so developed as to render it quite safe from lifting by the frost, and attacks of wire-worm would be almost unknown. If winter wheat were all drilled by the 10th of September, the entire fall would be at the farmer's disposal for clearing the land and sowing spring crops early. The crop could not become winter-proud, or be laid by the summer rains. The harvest would be from two to three weeks earlier. The harvest being over at least a fortnight earlier, would be of immense advantage in clearing the land. Seasons are frequently most unfavorable to late-sown cereals, but they are scarcely ever so to early-sown ones. On well-farmed lands, on the common practice, the average contents of the wheat-ears must be from 20 to 30. Were it grown on Major Hallett's system, the average contents would be, at the very least, from 40 to 60, and far more likely from 60 to 90; for under such a system so small an ear as one of 40 grains is quite the exception. And this increase of the *contents* of the ears would be obtained without any diminution of their number; the crop, in fact, would be doubled where now fairly good farming yields 30 bushels to the acre. These promises are not illusions, since a good many men in European countries, and in the United States also, have accomplished great results in agriculture by the application of commonly accepted principles of science. Major Hallett has himself grown 216 bushels from three acres with one bushel of seed, or 72 bushels to the acre; and over a whole field 82 bushels of barley, weighing 57 pounds to the bushel, from only two gallons of seed per acre.

In reference to the point of time of sowing, it must be borne in mind that the *rate* of growth for wheat during the different months in England is as follows:

Wheat sown on September 1st			comes up in	7	days.
" " October 1st	In a mild autumn,		" "	14	"
" " November 1st			" "	21	"
" " December 1st			" "	28	"

Taking this as the relative rate of wheat-growth, when it is up, then wheat which is up on the 1st of September makes in the first fifteen days of that month a growth equal to that of the whole of October; in the next ten days a growth equal to that of the whole of November; and, in the last five days of September, a growth equal to that of the first twenty days of December; or, in other words, wheat up on September 1st has a double autumn for growth before winter sets in; and, indeed, the case is in reality much stronger than this, for, if winter were to set in early, there would be for wheat sown at the end of October little or no autumn growth above-ground. The importance of every day (especially the early days) of September growth can not be overrated. To illustrate this, Miss Hallett made two very accurate drawings, which her father produced publicly. They were taken on December 30th, of two plants of wheat, each from a single *grain*, one of which was up on September 1st, the other on September 19th, and had thus lost the growth (after having come up) of the first nineteen days of September, the development of the earlier being double that of the later. These facts clearly point to the necessity of sowing in August. Nature, too, in shedding the grain in August, seems to indicate it as the proper time, or rather as a not unfit time, or the species would not be perpetuated. Within the present century it was the custom of many English farmers to go to wheat-sowing whenever it rained during harvest.

In determining the *space* to be assigned to each grain, we must deal with seed the result of continued selection, for the vital powers of the different grains of ordinary wheat are so *very* unequal that it would be impossible to fix upon any uniform distance. In planting grains of wheat in August, singly and twelve inches apart each way, all the requisite conditions of time and space seem to be best fulfilled, as will be seen further on. Wheat has been planted September 9th, 9 inches × 9 inches, and produced at the rate of 108 bushels per acre. It must be borne in mind at all times that it is a matter for mature study and judgment to correctly apportion the quantity of seed to the time of sowing, *and to all the existing surrounding circumstances.* A large quantity of seed sown early is just as much opposed to reason as a small quantity of seed sown late, and in fact more so, as in the first case it will become winter-proud and can not succeed, while the season may be such as to enable the last to do so. As a general basis, the drilling of wheat on a large scale might be conducted between the end of August and the 10th of September, at the rate of two to three gallons per acre; for each week later to the end of September, a gallon extra. When observing the unimpeded growth of cereals, there is seen to exist a striking variation in their modes of growth and powers of production. The superiority of some individuals over others is so marked in various ways as to lead irresistibly to the conclusion that

it must be hereditary, and on this fact the whole argument for selected seed-grain rests.

Let it not be supposed, from what has been stated, that the use of artificial fertilizers is sought to be prejudiced. On the contrary, if improvement can be secured without them, it will be immensely greater when aided by them. But while the purchase of good seed of pedigree stock in small quantity, though the farmer bought it at six dollars (Major Hallett frequently obtains five), would be a very economical proceeding if he does not use more than two gallons, the cost of which would only be one dollar and a half per acre, whereas buying common seed at one dollar, and using two to three bushels, involves a greater outlay. Therefore, in proposing this reform, it will be seen that it does not mean spending more, but less, on seed. The weeding, if done properly, may cost two dollars per acre; and if, after this, the grower has any money to spend on fertilizers, let him invest by all means. As a general rule, it may be confidently asserted that what would be saved in the outlay for seed would pay the cost of horse-hoeing.

Considering how rapid is the improvement of the process of selection during the first five years, its effect on the wheat-crop of the country would be enormous. If we take 500,000,000 bushels of wheat as the present product (which is much less than it is), then doubling the crop and adding at the very least fifty per cent improvement in quality to the grain, we should obtain an increase of about $750,000,000, without bringing an additional acre into cultivation. I have not said much of the effect on the corn-crop, but on a crop of 1,750,000,000 bushels, at an average value of 38 cents, would, if but fifty per cent increase, in five years could be realized on 27·5, be astounding. Today, the area in corn is not less than 65,000,000 acres; 12·50 bushels increase, at 40 cents per bushel, would be five dollars an acre, or $325,000,000: $1,075,000,000 of additional food in the short space of five years would give a new impetus to the milling trade in this country, and the hog-business would grow with a rapidity out of all proportion to its past career. Neither steel nor electricity can promise anything so great in so short a time, and no reform accomplished in this century will be able to measure this one.

Who will be the first to carry out such a scheme? In the Washington Department of Agriculture and in several other parts of the country, pedigree cereals have been used, but the results have not been taken much advantage of. The experimentalists of the State College farming-stations are especially qualified to lead in so important a work. The time is not far distant when intensive rather than extensive culture must be the rule of American farming. Already, in the East and in the South, men are finding it pays better to cultivate 100 acres well than 300 acres carelessly. When the hunger for large areas abates, we may hope to see attention paid to better cultivation.

The toil and misery, disappointment and mortification of skimming broad acres for meager results must give place to farming for profit. The change, when it comes, will be aided to some extent by professional guides and public men, but the foundation for it is within. The farmer is a near neighbor of hard facts, and living in days when everything is questioned, and nothing is taken for granted—when every institution in the land has to make good its claim to existence by the results produced—he is not likely to be deceived, or to grab any longer at the shadow for the substance. His wealth and happiness consist not in the number of his acres so much as in the principles of his farm practice. He will discover, as many of his *confrères* have already done, that the future of American agriculture will be determined by the extent to which fundamental truths of science are applied.

THE CAUSE OF SEA-SICKNESS.

By ROBERT W. LOVETT.

WHEN such an apparently simple disorder as sea-sickness exists in the midst of mankind for at least two thousand years, claiming yearly more victims, and all in spite of the best efforts of medical mankind to overcome it, it becomes of interest to inquire whether this is because its true nature has never been understood, or because it is essentially incurable.

The phenomena of sea-sickness are too well known to need detailed description. Violent and persistent vomiting is associated with it in most minds, and is the prominent symptom in most cases; but there are also a cold, clammy skin, headache, continuous nausea, great prostration, and indifference, the whole being accompanied by nervous irritability, and, in most cases, intense mental depression.

Plutarch was, perhaps, the first theorist on the subject. He thought that sea-sickness was caused by the smell of the salt-water; and, following him, men have propounded theory after theory, only to leave us of to-day with a large stock of theories, and but few good results to show for them.

Perhaps the most acceptable theory to-day is the one which places the origin of the trouble in the inner ear. The ear consists of three parts: the outer of these runs in as far as the drum; the middle part is inside of the drum, and contains the chain of ear-bones; while the inner ear is a complicated affair, containing the essential organ of hearing.

As far as we are concerned, the inner ear is a membranous bag filled with fluid, and situated in the solid bone. From the back part of this bag run out three semicircular tubes communicating at both

their ends with the bag or vestibule. These run in three different planes, and are lined with hair-like nerve-filaments, which are much more abundant and more sensitive at the anterior part of the tubes. The tubes are filled with liquid in which float little calcareous particles, the otoliths. These tubes are known as the semicircular canals. It was difficult to see what connection with the sense of hearing these canals could possibly have, and some time ago it was noticed that injuries to these impaired the sense of hearing in no way, but caused most curious effects in the loss of equilibrium.

For instance, in pigeons, when the vertical canal was cut, the bird turned a series of back somersaults; and, when the horizontal canal was cut, the pigeon whirled around in an horizontal plane, in every case tending to rotate in the plane of the canal which was cut. And what is especially interesting to us is, that in these and other experiments iritation or injury to these canals was almost invariably followed by vomiting. Experiments, by Professor Ferrier and others, point to a very close relation between these canals and the sense of equilibrium, and an especially strong suggestion is given by the disease known as labyrinthine vertigo, or Ménière's disease. This is characterized by an irritated and congested condition of these semicircular canals, due to some internal cause, and its symptoms are the same throbbing in the head, the pale, cold skin, and vomiting, as in sea-sickness, and in addition the patient reels and staggers, being unable to keep his balance. In this disease we seem to have the exact reverse of sea-sickness, the irritated condition of the canals causing the unusual movements of the body; whereas in sea-sickness we have the unusual movements of the body which result from the pitching of the ship, causing the irritation of the canals, and in both cases the irritated state of the semicircular canals is accompanied by vomiting. The mechanical explanation of why such irregular motion should cause irritation of the canals seems simple. By the pitching movements of the ship, which are by far the worst, the head is carried backward and forward through a long arc. At the end of the descent the head stops, but by its inertia the fluid in the canals rushes on and washes the otoliths up against the nerve-filaments at the front of the canals. These are extremely sensitive, and the repetition of this process a few times serves to establish an excessive irritation which is expressed by giddiness and vomiting. Why such gradual motions should cause sea-sickness, while much more violent ones, such as horseback-riding, do not, can only be explained by saying that in the more violent ones the individual has a stimulus to adapt his positions to the motion, which he has not in the often unnoticed pitching of a ship. At any rate, this theory explains why lying down should afford relief, as the otoliths then rest at the back and less sensitive part of the canals; and it also explains why riding backward should cause nausea and giddiness, as here, of course, the otoliths drag behind and irritate the anterior parts of the canals.

Moreover, in some recent inquiries addressed to deaf-mutes upon another subject, the fact was noticed that all who were insusceptible to dizziness on account of the impairment of their semicircular canals by disease reported themselves also exempt from sea-sickness.

But the semicircular canals must not receive all the credit. The viscera of the abdomen are very full of blood, and irritated in sea-sickness, and this condition will cause vomiting, as shown by very many experiments on animals. The intestines are attached loosely to the backbone by a fold of membrane containing some very large blood-vessels. Ordinarily the intestines are held up and supported in place by the muscles of the abdomen, and consequently do not drag too heavily on their attachment. But in sea-sickness, it is said, either on account of confused messages sent to them from the irritated semicircular canals, or because of the novelty and uncertainty of the motions of the ship, these muscles are unable to tell when to contract and when to relax, thus affording but poor support to the intestines. Consequently by their inertia the intestines bulge forward at the end of each descent of the ship, thereby stretching and irritating their attachment, and in consequence the abdominal blood-vessels are engorged with blood, and this condition is expressed by vomiting, which is merely Nature's effort to equalize the circulation. Force is lent to this view of sea-sickness by the fact that jumping from a great height causes fearful nausea on reaching the ground—in this case also the intestines pushing forward the abdominal wall and stretching their attachment.

There is probably a minor kind of sea-sickness, caused by the mere churning about of food in the stomach, irritating the nerves there as they would be irritated by a dose of mustard. This is often the sort experienced in small boats, and is at once relieved by vomiting.

The power of the imagination as one of the causes of sea-sickness ought not to go without some mention. Whether or not it is more powerful here than in other diseases it would be hard to say, but so prominent is the mental effort that Mr. Bache some years ago wrote a very interesting article on the subject, in which he maintained that sea-sickness was wholly of mental origin; that the idea of motion was the result of the concurrent testimony of the senses; and that in a new motion, where there was a conflict of impressions, the brain was disturbed. He said that motion caused nausea in two cases—1. When the motion of the observer's body is in doubt; 2. When the motion is acknowledged by the mind but the motion is not felt. But, however attractive this may be, it offers us little that is tangible. Of the very many other causes suggested, it seems only necessary to name the prominent ones. Naylor suggested spasm of the capillaries of the brain. Barris attributed it to the instability of surrounding objects. Stocker thinks it largely due to a partial vacuum in the lungs. Wollaston believed it was caused by the rise and fall of blood in the

brain, as the mercury would rise and fall in a barometer, under like conditions; and Dr. Barker considers it the result of the sudden changes in the relations of the fluids and solids in the body.

Whether or not the individual is to be sick, and the duration and extent of his sickness, seem to depend to a certain extent on the general condition of the system, and also somewhat upon wholly unknown conditions, in many cases the most robust yielding the first. In this connection it is an interesting fact that children under three or four years are almost invariably exempt from sea-sickness, although ordinarily they vomit so much more readily than adults.

This is no place for the discussion of remedies. Bromide of sodium is the prominent one just at present, and probably does lessen the nervous susceptibility somewhat; but let its advocates read the glowing testimonials in favor of Chapman's ice-bags for the spine, nitrite of amyl, champagne, chloral, and all the rest. The belt to support the abdomen seems a rational remedy, but it was first proposed for that use in 1814, and but few to-day have even heard of it, and it seems fair to assume that suffering mankind would not have discarded a really efficient remedy.

In conclusion, what I have tried to show is, that the stomach is not the cause of the disorder, although generally the seat of it; that the organs irritated seem to be the semicircular canals of the ear, or the abdominal viscera, or both, which become full of blood and cause vomiting, which seems rather an effort of Nature to equalize the circulation than any desire on the part of the stomach to rid itself of its contents.

METERS FOR POWER AND ELECTRICITY.*

By C. VERNON BOYS, Esq.

THE subject of this evening's discourse, "Meters for Power and Electricity," is unfortunately, from a lecturer's point of view, one of extreme difficulty; for it is impossible to fully describe any single instrument of the class without diving into technical and mathematical niceties which this audience might well consider more scientific than entertaining. If, then, in my endeavor to explain these instruments and the purposes which they are intended to fulfill, in language as simple and as untechnical as possible, I am not so successful as you have a right to expect, I must ask you to lay some of the blame on my subject and not all on myself.

I shall at once explain what I mean by the term "meter," and I shall take the flow of water in a trough as an illustration of my mean-

* Address at the Royal Institution of Great Britain, delivered Friday, March 2, 1883.

ing. If we hang in a trough a weighted board, then, when the water flows past it, the board will be pushed back; when the current of water is strong, the board will be pushed back a long way; when the current is less, it will not be pushed so far; when the water runs the other way, the board will be pushed the other way. So, by observing the position of the board, we can tell how strong the current of water is at any time. Now, suppose we wish to know, not how strong the current of water is at this time or at that, but how much water altogether has passed through the trough *during* any time, as, for instance, one hour. Then, if we have no better instrument than the weighted board, it will be necessary to observe its position continuously, to keep an exact record of the corresponding rates at which the water is passing, every minute, or better every second, and to add up all the values obtained. This would, of course, be a very troublesome process. There is another kind of instrument which may be used to measure the flow of the water: a paddle-wheel or screw. When the water is flowing rapidly, the wheel will turn rapidly; when slowly, the wheel will turn slowly; and, when the water flows the other way, the wheel will turn the other way, so that, if we observe how fast the wheel is turning, we can tell how fast the water is flowing. If, now, we wish to know how much water altogether has passed through the trough, the number of turns of the wheel, which may be shown by a counter, will at once tell us. There are, therefore, in the case of water, two kinds of instruments, one which measures *at* a time, and the other *during* a time. The term meter should be confined to instruments of the second class only.

As with water so with electricity, there are two kinds of measuring instruments: one, of which the galvanometer may be taken as a type, which shows by the position of a magnet how strong a current of electricity is *at* a time; and the other, which shows how much electricity has passed *during* any time. Of the first, which are well understood, I shall say nothing; the second, the new electric meters and the corresponding meters for power, are what I have to speak of to-night.

It is hardly necessary for me to mention the object of making electric meters. Every one who has had to pay his gas bill once a quarter probably quite appreciates what the electric meters are going to do, and why they are at the present time attracting so much attention. So soon as you have electricity laid on in your houses, as gas and water are laid on now, so soon will a meter of some sort be necessary in order that the companies which supply the electricity may be able to make out their quarterly bills, and refer complaining customers to the faithful indications of their extravagance in the mysterious cupboard in which the meter is placed.

The urgent necessity for a good meter has called such a host of inventors into the field that a complete account of their labors is more than any one could hope to give in an hour. Since I am one of this

host, I hardly like to pick out those inventions which I consider of value. I can not describe all; I can not act as a judge and say these only are worthy of your attention, and I do not think I should be acting fairly if I were to describe my own instruments only and ignore those of every one else. The only way I see out of the difficulty is to speak more particularly about my own work in this direction, and to speak generally on the work of others.

I must now ask you to give your attention for a few minutes to a little abstract geometry. We may represent any changing quantity, as, for instance, the strength of an electrical current, by a crooked line. For this purpose we must draw a straight line to represent time, and make the distance of each point of the crooked line above the straight line a measure of the strength of the current at the corresponding time. The size of the figure will then measure the quantity of electricity that has passed, for, the stronger the current is, the taller the figure will be, and the longer it lasts the longer the figure will be; either cause makes both the quantity of electricity and the size of the figure greater and in the same proportion: so the one is a measure of the other. Now, it is not an easy thing to measure the size of a figure, the distance round it tells nothing; there is, however, a geometrical method by which its size may be found. Draw another line, with a great steepness where the figure is tall, and with a less steepness where the height is less, and with no steepness or horizontal where the figure has no height. If this is done accurately, the height to which the new line reaches will measure the size of the figure first drawn; for, the taller the figure is, the steeper the hill will be: the longer the figure, the longer the hill; either cause makes both the size of the figure and the height of the hill greater, and in the same proportion: so the one is a measure of the other; and so, moreover, is the height of the hill, which can be measured by a scale, a measure of the quantity of electricity that has passed.

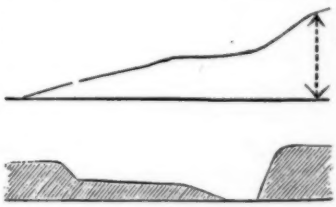


FIG. 1.

The first instrument that I made, which I have called a "cart" integrator, is a machine which, if the lower figure is traced out, will describe the upper. I will trace a circle, the instrument follows the curious bracket-shaped line that I have already made sufficiently black to be seen at a distance, the height of the new line measures the size of the circle, the instrument has squared the circle. This machine is a thing of mainly theoretical interest; my only object in showing it is to explain the means by which I have developed a practical and automatic instrument of which I shall speak presently. The guiding principle in the cart integrator is a little three-wheeled cart, whose front wheel is controlled by the machine. This, of course, is invisible at a

distance, and therefore I have here a large front wheel alone. On moving this along the table, any twisting of its direction instantly causes it to deviate from its straight path; now, suppose I do not let it deviate, but compel it to go straight, then at once a great strain is put upon the table, which is urged the other way. If the table can move, it will instantly do so. A table on rollers is inconvenient as an

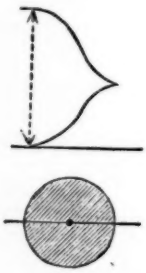


FIG. 2.

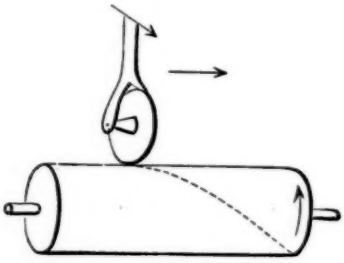


FIG. 3.

instrument, let us therefore roll it round into a roller, then on moving the wheel along it the roller will turn and the amount by which it turns will correspond to the height of the second figure drawn by the cart integrator. If, therefore, the wheel is inclined by a magnet under the influence of an electric current, or by any other cause, the whole amount of which we wish to know, then the number of turns of the roller will tell us this amount; or to go back to our water analogy, if we had the weighted board to show current strength, and had not the paddle-wheel to show total quantity, we might use the board to incline a disk in contact with a roller, and then drag the roller steadily along by clock-work. The number of turns of the roller would give the quantity of water. Instruments that will thus add up continuously indications at a time, and so find amounts during a time, are called integrators.

The most important application that I have made at present of the integrator described is what I have called an engine-power meter. The instrument is on the table, but, as it is far too small to be seen at a distance, I have arranged a large model to illustrate its action. The object of this machine is to measure how much work an engine has done during any time, and show the result on a dial, so that a workman may read it off at once without having to make any calculations.

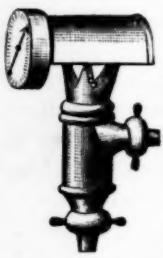


FIG. 4.

Before I can explain how work is measured, perhaps I had better say a few words about the meaning of the word "work." Work is done when pressure overcomes resistance, producing motion. Neither motion nor pressure alone is work. The two factors, pressure and motion, must occur together. The work done is found by multiplying the pressure by the distance moved. In an engine, steam pushes the

piston first one way then the other, overcomes resistance, and does work. To find this, we must multiply the pressure by the motion at every instant and add all the products together. This is what the engine-power meter does, and it shows the continuously growing result on a dial. When the piston moves, it drags the cylinder along ; where the steam presses, the wheel is inclined. Neither action alone causes the cylinder to turn, but when they occur together the cylinder turns, and the number of turns registered on a dial shows with mathematical accuracy how much work has been done.

In the steam-engine work is done in an alternating manner, and it so happens that this alternating action exactly suits the integrator. Suppose, however, that the action, whatever it may be, which we wish to estimate, is of a continuous kind, such for instance as the continuous passage of an electric current. Then if, by means of any device, we can suitably incline the wheel, so long as we keep pushing the cylinder along, so long will its rotation measure and indicate the result ; but there must come a time when the end of the cylinder is reached. If, then, we drag it back again, instead of going on adding up, it will begin to take off from the result, and the hands on the dial will go backward, which is clearly wrong. So long as the current continues, so long must the hands on the dial turn in one direction. This effect is obtained in the instrument now on the table, the electric energy meter, in this way : Clock-work causes the cylinder to travel backward and forward by means of what is called a mangle-motion, but, instead of moving always in contact with one wheel, the cylinder goes forward in contact with one and back in contact with another on its opposite side. In this instrument the inclination of the wheels is effected by an arrangement of coils of wire, the main current passing through two fixed concentric solenoids, and a shunt current through a great length of fine wire on a movable solenoid, hanging in the space between the others. The movable portion has an equal number of turns in opposite directions, and is therefore unaffected by magnets held near it. The effect of this arrangement is that the energy of the current, that is, the quantity multiplied by the force driving it, or the electrical equivalent of mechanical power, is measured by the slope of the wheels, and the amount of work done by the current during any time, by the number of turns of the cylinder, which is registered on a dial. Professors Ayrton and Perry have devised an instrument which is intended to show the same thing. They make use of a clock, and cause it to go too fast or too slow by the action of the main on the shunt current ; the amount of wrongness of the clock, and not the time shown, is said to measure the work done by the current. This method of measuring the electricity by the work it has done is one which has been proposed to enable the electrical companies to make out their bills.

The other method is to measure the amount of electricity that has passed, without regard to the work done. There are three lines on

which inventors have worked for this purpose: The first, which has been used in every laboratory ever since electricity has been understood, is the chemical method. When electricity passes through a salt solution, it carries metal with it, and deposits it on the plate by which the electricity leaves the liquid. The amount of metal deposited is a measure of the quantity of electricity. Mr. Sprague and Mr. Edison have adopted this method; but, as it is impossible to allow the whole of a strong current to pass through a liquid, the current is divided; a small proportion only is allowed to pass through. Provided that the proportion does not vary, and that the metal never has any motions on its own account, the increase in the weight of one of the metal plates measures the quantity of electricity.

The next method depends on the use of some sort of integrating machine, and this, being the most obvious method, has been attempted by a large number of inventors. Any machine of this kind is sure to go, and is sure to indicate something, which will be more nearly a measure of the electricity as the skill of the inventor is greater.

Meters for electricity of the third class are dynamical in their action, and I believe that what I have called the vibrating meter was the first of its class. It is well known that a current passing round iron makes it magnetic. The force which such a magnet exerts is greater when the current is greater, but it is not simply proportional; if the current is twice or three times as strong, the force is four times or nine times as great; or, generally, the force is proportional to the square of the current. Again, when a body vibrates under the influence of a controlling force, as a pendulum under the influence of gravity, four times as much force is necessary to make it vibrate twice as fast, and nine times to make it vibrate three times as fast; or, generally, the square of the number measures the force. I will illustrate this by a model. Here are two sticks nicely balanced on points, and drawn into a middle position by pieces of tape to which weights may be hung. They are identical in every respect. I will now hang a one-pound weight to each tape, and let the pieces of wood swing. They keep time together absolutely. I will now put two pounds on one tape. It is clear that the corresponding stick is going faster, but certainly not twice as fast. I will now hang on four pounds. One stick is going at exactly twice the pace of the other. To make one go three times as fast, it is obviously useless to put on three pounds, for it takes four to make

FIG. 5.

it go twice as fast. I will hang on nine pounds. One now goes exactly three times as fast as the other. I will now put four pounds on the first, and leave the nine pounds on the second: the first goes twice while the second goes three times. If instead of a weight we use electro-magnetic force to control the vibrations of a body, then twice the current produces four times the force; four times the force produces twice the rate; three times the current produces nine times the force; nine times the force produces three times the rate, and so on: or the rate is directly proportional to the current strength. There is on the table a working meter made on this principle. I allow the current that passes through to pass also through a galvanometer of special construction, so that you can tell by the position of a spot of light on a scale the strength of the current. At the present time there is no current; the light is on the zero of the scale, the meter is at rest. I now allow a current to pass from a battery of the new Faure-Sellon-Volckmar cells which the Storage Company have kindly lent me for this occasion. The light moves through one division on the scale, and the meter has started. I will ask you to observe its rate of vibration. I will now double the current; this is indicated by the light moving to the end of the second division on the scale: the meter vibrates twice as fast. Now the current is three times as strong, now four times, and so on. You will observe that the position of the spot of light and the rate of vibration always correspond. Every vibration of the meter corresponds to a definite quantity of electricity, and causes a hand on a dial to move on one step. By looking at the dial, we can see how many vibrations there have been, and therefore how much electricity has passed. Just as the vibrating sticks in the model in time come to rest, so the vibrating part of the meter would in time do the same, if it were not kept going by an impulse automatically given to it when required. Also, just as the vibrating sticks can be timed to one another by sliding weights along them, so the vibrating electric meters can be regulated to one another so that all shall indicate the same value for the same current, by changing the position or weight of the bobs attached to the vibrating arm.

The other meter of this class, Dr. Hopkinson's, depends on the fact that centrifugal force is proportional to the square of the angular velocity. He therefore allows a little motor to drive a shaft faster and faster, until centrifugal force overcomes electro-magnetic attraction, when the action of the motor ceases. The number of turns of the motor is a measure of the quantity of electricity that has passed.

I will now pass on to the measurement of power transmitted by belting. The transmission of power by a strap is familiar to every one in a treadle sewing-machine or an ordinary lathe. The driving force depends on the difference in the tightness of the two sides of the belt, and the power transmitted is equal to this difference multiplied

by the speed; a power-meter must, therefore, solve this problem—it must subtract the tightness of one side from the tightness of the other side, multiply the difference by the speed at every instant, and add all the products together, continuously representing the growing amount on a dial. I shall now show for the first time an instrument that I have devised, that will do all this in the simplest possible manner. I have here two wheels connected by a driving-band of India-rubber, round which I have tied every few inches a piece of white silk ribbon. I shall turn one a little way, and hold the other. The driving-force is indicated by a difference of stretching: the pieces of silk are much farther apart on the tight side than they are on the loose. I shall now turn the handle, and cause the wheels to revolve; the motion of the band is visible to all. The India-rubber is traveling faster on the tight side than on the loose side, nearly twice as fast; this must be so, for, as there is less material on the tight side than on the loose, there would be a gradual accumulation of the India-rubber round the driven pulley, if they traveled at the same speed; since there is no accumulation, the tight side must travel the fastest. Now, it may be shown mathematically that the difference in the speeds is proportional both to the actual speed and to the driving strain; it is therefore a measure of the power or work being transmitted, and the difference in the distance traveled is a measure of the work done. I have here a working machine which shows directly on a dial the amount of work done; this I will show in action directly. Instead of India-rubber, elastic steel is used. Since the driving-pulley has the velocity of the tight side, and the driven of the loose side of the belt, the difference in the number of their turns, if they are of equal size, will measure the work. This difference I measure by differential gearing which actuates a hand on a dial. I may turn the handle as fast as I please; the index does not move, for no work is being done. I may hold the wheel and produce a great driving-strain; again the index remains at rest, for no work is being done. I now turn the handle quickly, and lightly touch the driven wheel with my finger. The resistance, small though it is, has to be overcome; a minute amount of work is being done, the index creeps around gently. I will now put more pressure on my finger, more work is being done, the index is moving faster; whether I increase the speed or the resistance, the index turns faster; its rate of motion measures the power, and the distance it has moved, or the number of turns, measures the work done. That this is so I will show by an experiment. I will wind up in front of a scale a seven-pound weight; the hand has turned one third around; I will now wind a twenty-eight-pound weight up the same height; the hand has turned four thirds of

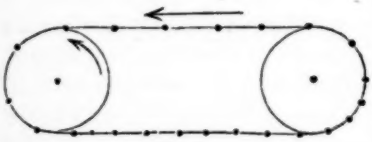


FIG. 6.

a turn. There are other points of a practical nature with regard to this invention which I can not now describe.

There is one other class of instruments which I have developed, of which time will let me say very little. The object of this class of instruments is to divide the speed with which two registrations are being effected, and continuously record the quotient. In the instrument on the table two iron cones are caused to rotate in time with the registrations; a magnetized steel reel hangs on below. This reel turns about, and runs up or down the cones until it finds a place at which it can roll at ease. Its position at once indicates the ratio of the speeds which will be efficiency, horse-power per hour, or one thing in terms of another. Just as the integrators are derived from the steering of an ordinary bicycle, so this instrument is derived from the double steering of the "Otto" bicycle.

Though I am afraid that I have not succeeded in the short time at my disposal in making clear all the points on which I have touched, yet I hope that I have done something to remove the very prevalent opinion that meters for power and electricity do not exist.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

IV.—ALBUMEN AND ITS CHANGES.

LET us now make practical application of the laws of albumen coagulation that were demonstrated in the test-tube experiment. The non-professional student may do this at the breakfast fireside. The apparatus required is a saucepan large enough for boiling a pint of water—the materials two eggs.

Cook the first in the orthodox manner by keeping it in boiling water three and a half minutes. Then place the second in this same boiling water; but, instead of keeping the saucepan over the fire, place it on the hearth and leave it there, with the egg in it, about ten minutes or more. A still better way of making the comparative experiment is to use for the second egg a water-bath, or *bain marie* of the French scientific cook; a vessel immersed in boiling or nearly boiling water, like a glue-pot, and therefore not quite so hot as its source of heat. In this case a thermometer should be used, and the water surrounding the egg be kept at or near 180° Fahr. Time of immersion about ten minutes or more.

A comparison of results will show that the egg that has been cooked at a temperature of more than 30° below the boiling-point of water is tender and delicate, evenly so throughout, no part being hard while another part is semi-raw and slimy.

I said "ten minutes or more," because, when thus cooked, a prolonged exposure to the hot water does no mischief; if the temperature of 160° is not exceeded, it may remain for half an hour; in fact, the perfection of cooking, according to my experience (I always cook my own eggs when I have the opportunity and can spare the time), is attained when kept at 160° about twenty minutes. The 180° is abovenamed because the rising of the temperature of the egg itself is due to the difference between its own temperature and that of the water, and, when that difference is very small, this takes place very slowly, besides which the temperature of the water is, of course, lowered in raising that of the cold egg.

In order to test this principle severely, I have just made the following experiment: At 10.30 P. M. I placed a new-laid egg in a covered stone-ware jar, of about one pint capacity, and filled this with boiling water; then wrapped the jar in many folds of flannel—so many that, with the egg, they filled a hat-case in which I placed the bundle—and left it there until breakfast-time next morning, ten hours later.

On unrolling, I found the water cooled down to 95°, that the yolk of the egg was hard, but the white only just solidified and much softer than the yolk. On repeating the experiment, and leaving the egg in its flannel coating for four hours, the temperature of the water was 123°, and the egg in similar condition—the white cooked in perfection, delicately tender, but the yolk too hard. A third experiment of twelve hours, water at 200° on starting, gave similar result as regards the state of the egg.

This brings out a fact hitherto unknown to either cooks or chemists, viz., that the yolk coagulates firmly at a lower temperature than the white. Whether this is due to a different condition of the albumen itself or the action of the other constituents on the albumen, requires further research to determine.

When eggs are cooked in the ordinary way, the three and a half minutes' immersion is insufficient to allow the heat to pass fully to the middle of the egg, and therefore the white is subjected to a higher temperature than the yolk. In my experiment there was time for a practically uniform diffusion of the heat throughout.

I shall describe hereafter what is called the "Norwegian" cooking apparatus, wherein fowls, etc., are cooked as the eggs were in my hat-case.

Albumen exists in flesh as one of its juices, rather than in a definitely organized condition. It is distributed between the fibers of the lean (i. e., the muscles), and it lubricates the tissues generally, besides being an important constituent of the blood itself—of that portion of the blood which remains liquid when the blood is dead, i. e., the serum. As blood is not an ordinary article of food, excepting in the form of "black-puddings," its albumen need not be here considered, nor the debated question of whether its albumen is identical with the albumen of the flesh.

Existing thus in a liquid state in our ordinary flesh-meats, it is liable to be wasted in the course of cookery, especially if the cook has only received the customary technical education and remains in technological ignorance.

To illustrate this, let us suppose that a leg of mutton, a slice of cod, or a piece of salmon, is to be cooked in water, "boiled," as the cook says. Keeping in mind the results of the previously-described experiments on the egg-albumen, and also the fact that in its liquid state albumen is diffusible in water, the reader may now stand as scientific umpire in answering the question whether the fish or the flesh should be put in hot water at once, or in cold water, and be gradually heated. The "big-endians" and the "little-endians" of Lilliput were not more definitely divided than are certain cookery authorities on this question in reference to fish. I refer to the two which are practically consulted in my own household, that by Mrs. Beeton, and some sheet-tablets hanging in the kitchen. Mrs. Beeton says pour cold water on the fish, the tablets say immerse in hot water.

Confining our attention at present to the albumen, what must happen if the fish or flesh is put in cold water, which is gradually heated? Obviously a loss of albumen by exudation and diffusion through the water, especially in the case of sliced fish or of meat exposing much surface of fibers cut across. It is also evident that such loss of albumen will be shown by its coagulation when the water is sufficiently heated.

Practical readers will at once recognize in the "scum" which rises to the surface of the boiling water, and in the milkiness that is more or less diffused throughout it, the evidence of such loss of albumen. This loss indicates the desirability of plunging the fish or flesh at once into water hot enough to immediately coagulate the superficial albumen, and thereby plug the pores through which the inner albuminous juice otherwise exudes.

But this is not all. There are other juices besides the albumen, and these are the most important of the *flavoring* constituents, and, *with the other constituents of animal food*, have great nutritive value; so much so, that animal food is quite tasteless and almost worthless without them. I have laid especial emphasis on the above qualification, lest the reader should be led into an error originated by the bone-soup committee of the French Academy, and propagated widely by Liebig —that of regarding these juices as a concentrated nutriment when taken alone.

They constitute collectively the *extractum carnis*, which, with the addition of more or less of gelatine (the less the better), is commonly sold as Liebig's "Extract of Meat." It is prepared by simply mincing lean meat, exposing it to the action of cold water, and then evaporating down the solution of extract thus obtained.

I shall return to this on reaching the subjects of clear soups and

beef-tea, at present merely adding, as evidence of the importance of retaining these juices in cooked meat, that the extracts of beef, mutton, and pork may be distinguished by their specific flavors. Some "Extract of Kangaroo," sent to me many years ago from Australia by the Ramornie Company, made a soup that was curiously different in flavor from the other extract similarly prepared by the same company. Epicures pronounced it very choice and "gamy." When these juices are removed from the meat, mutton, beef, pork, etc., the remaining solids are all alike, so far as the palate alone can distinguish.

Let us now apply these principles practically to the case of a leg of mutton. First, in order to seal the pores, the meat should be put into boiling water; the water should be kept boiling for five or ten minutes. A coating of firmly-coagulated albumen will thus envelop the joint. Now, instead of boiling or "simmering" the water, set the saucepan aside, where the water will retain a temperature of about 180°, or 32° below the boiling-point. Continue this about half as long again, or double the usual time given in the cookery-books for boiling a leg of mutton, and try the effect. It will be analogous to that of the egg cooked on the same principles, and appreciated accordingly.

The usual addition of salt to the water is very desirable. It has a threefold action: first, it directly acts on the superficial albumen with coagulating effect; second, it slightly raises the boiling-point of the water; and, third, by increasing the density of the water, the "exosmosis," or oozing out of the juices, is less active. These actions are slight, but all co-operate in keeping in the juices.

I should add that a leg of mutton for boiling should be fresh, and not "hung" as for roasting. The reasons for this hereafter.

V.—FISH.

"Please, mum, the fish would break to pieces," would be the probable reply of the unscientific cook, to whom her mistress had suggested the desirability of cooking fish in accordance with the principles expounded in my last. Many kinds of fish would thus break if the popular notions of "boiling" were carried out, and the fish suddenly immersed in water that was agitated by the act of ebullition. But this difficulty vanishes when the true theory of cookery is understood and practically applied by cooking the fish from beginning to end without ever boiling the water at all.

In the case of the leg of mutton, chosen as a previous example, the plunging in boiling water and maintenance of boiling-point for a few minutes was unobjectionable, as the most effectual means of obtaining the firm coagulation of a superficial layer of albumen; but, in the case of fragile fish, this advantage can only be obtained in a minor degree by using water just below the boiling-point, for the breaking of the fish by the agitation of the boiling water does more than merely disfigure it when served; it opens outlets to the juices, and thereby

depreciates the flavor, besides sacrificing some of the nutritious albumen.

To demonstrate this experimentally, take two equal slices from the same salmon, cook one according to Mrs. Beeton and other orthodox authorities by putting it into cold water, or pouring cold water over it, then heating up to the boiling-point. Cook the other slice by putting it into water nearly boiling (about 200° Fahr.), and keeping it at about 180° to 200°, but never boiling at all. Then dish up, examine, and taste. The second will be found to have retained more of its proper salmon color and flavor, the first will be paler and more like cod, or other white fish, owing to the exosmosis or oozing out of its characteristic juices.

I was surprised, and at first considerably puzzled, at what I saw of salmon-cooking in Norway. As this fish is so abundant there (two cents per pound would be regarded as a high price in the Tellemark), I naturally supposed that large experience, operating by natural selection, would have evolved the best method of cooking it, but found that, not only in the farm-houses of the interior, but at such hotels as the Victoria, in Christiania, the usual cookery was effected by cutting the fish into small pieces and soddening it in water in such wise that it came to table almost colorless, and with merely a faint suggestion of what we prize as the rich flavor of salmon. A few months' experience and a little reflection solved the problem. Salmon is so rich, and has so special a flavor, that when daily eaten it soon palls on the palate. Everybody has heard the old story of the clause in the indentures of the Aberdeen apprentices, binding the masters not to feed the boys on salmon more frequently than twice a week. If the story is not true it ought to be, for salmon every day would have the same effect as the daily breakfasts of boiled fat pork and dumplings on the voracious hero of another story.

By boiling out the rich oil of the salmon, the Norwegian reduces it nearly to the condition of codfish, concerning which I learned a curious fact from the two old Doggerbank fishermen with whom I had a long sailing-cruise from the Golden Horn to the Thames. They agreed in stating that codfish is like bread, that they and all their mates lived upon it (and sea-biscuits) day after day for months together, and never tired, while richer fish ultimately became repulsive if eaten daily. This statement was elicited by an immediate experience. We were in the Mediterranean, where the bonetta was very abundant, and every morning and evening I amused myself by spearing them from the martingale of the schooner, and so successfully that all hands (or rather mouths) were abundantly supplied with this delicious, dark-fleshed, full-blooded, and high-flavored fish. I began by making three meals a day on it, and at the end of about a week was glad to return to the ordinary ship's fare of salt-junk and chickens.

This is not exactly a digression, seeing that the philosophy of the

appetite is fundamental to that of cookery. A healthy, unvitiated appetite is an index to the requirements of nutrition. Other illustrations of this will be presented as we proceed.

Another important constituent of animal food is *gelatin* or *gelatine*. It constitutes a large proportion of the whole bulk of the animal; it is, in fact, the main constituent of the animal tissues, the walls of the cells of which animals are built up being composed of gelatin. I will not here discuss the question of whether Haller's remark, "Dimidium corporis humani gluten est" ("Half of the human body is gelatin"), should or should not now, as Lehmann says, "be modified to the assertion that half of the solid parts of the animal body *are convertible, by boiling with water*, into gelatin." Lehmann and others give the name of "glutin" to the component of the animal tissue as it exists there, and gelatin to it when acted upon by boiling water. Others indicate this difference by naming the first "gelatin," and the second "gelatine."

The difference upon which these distinctions are based is directly connected with my present subject, as it is just the difference between the raw and the cooked material, which, as we shall presently see, consists mainly in solubility.

Even the original or raw gelatine varies materially in this respect. There is a decidedly practical difference between the solubility of the cell-walls of a young chicken and those of an old hen. The pleasant fiction which describes all the pretty gelatine preparations of the table as "calf's-foot jelly," is founded on the greater solubility of the juvenile hoof, as compared with that of the adult ox or horse, or to the parings of hides about to be used by the tanner. All these produce gelatine by boiling, the calves' feet with comparatively little boiling.

Besides these differences there are decided varieties, or, I might say, species of gelatine, having slight differences of chemical composition and chemical relations. There is *chondrine*, or cartilage gelatine, which is obtained by boiling the cartilages of the ribs, larynx, or joints for eighteen or twenty hours in water. Then there is *fibroine*, obtained by boiling spiders' webs and the silk of silk-worms or other caterpillars. These exist as a liquid inside the animal, which solidifies on exposure. The fibers of sponge contain this modification of gelatine.

Another kind is *chitine*, which constituted the animal food of St. John the Baptist, when he fed upon locusts and wild honey. It is the basis of the bodily structure of insects; of the spiral tubes which permeate them throughout, and are so wonderfully displayed when we examine insect anatomy by aid of the microscope, also of their intestinal canal, their external skeleton, scales, hairs, etc. It similarly forms the true skeleton and bodily framework of crabs, lobsters, shrimps, and other crustacea, bearing the same relation to their shells, muscles, etc., that ordinary gelatine does to the bones and softer tissues of the vertebrata; it is "the bone of their bones, and the flesh of their flesh."

It is obtainable by boiling these creatures down, but is more difficult of solution than the ordinary gelatine of beef, mutton, fish, and poultry. To this difficulty of solution in the stomach is to be attributed, I suspect, the nightmare that follows lobster-suppers.

I once had an experience of the edibility of the shells of a crustacean. When traveling, I always continue the pursuit of knowledge in restaurants by ordering anything that appears on the bill of fare that I have never heard of before, or can not translate or pronounce. At a Neapolitan restaurant, I found "*Gambers di mare*" on the *carta*, which I translated "Leggy things of the sea," or sea-creepers, and ordered them accordingly. They proved to be shrimps fried in their shells, and were very delicious—like white-bait, but richer. The chitine of the shells was thus cooked to crispness, and no evil consequences followed. If reduced to locusts, I should, if possible, cook them in the same manner, and, as they have similar chemical composition, they would doubtless be equally good.

Should any epicurean reader desire to try this dish (the shrimps, I mean), he should fry them as they come from the sea, not as they are sold by the fishmonger, these being already boiled in salt-water (usually in sea-water) by the shrimpers who catch them, the chitin being indurated thereby.

The introduction of fried and tinned locust as an epicurean delicacy would be a boon to suffering humanity, by supplying industrial compensation to the inhabitants of districts subject to periodical plagues of locust invasion. The idea of eating them appears repulsive *at first*, so would that of eating such creepy-crawly things as shrimps, if no adventurous hero had made the first exemplary experiment. Chitine is chitine, whether elaborated on the land or secreted in the sea. The vegetarian locust and the cicala are free from the pungent essential oils of the really unpleasant cockchafer.

VI.—GELATINE AND ITS CHANGES.

Those who are disposed to bow too implicitly to mere authority in scientific matters will do well to study the history and the treatment which gelatine has received from some of the highest of these authorities. Our grandmothers believed it to be highly nutritious, prepared it in the form of jellies for invalids, and estimated the nutritive value of their soups by the consistency of the jelly which they formed on cooling, which thickness is due to the gelatine they contain. Isinglass, which is simply the swim-bladder of the sturgeon and similar fishes cut into shreds, was especially esteemed, and sold at high prices. This is the purest natural form of gelatine.

Everybody believed that the callipash and callipee of the alderman's turtle-soup contributed largely to his proverbial girth, and those who could not afford to pay for the gelatine of the reptile made mock-turtle from the gelatinous tissues of calves'-head and pigs'-feet. The

delicacies of the Orient, the edible birds'-nests, the sea-slugs, etc., so highly esteemed for their nutritious properties, are varieties of gelatine.

About fifty or sixty years ago the French Academy of Sciences appointed a bone-soup commission, consisting of some of the most eminent *savants* of the period. They worked for above ten years upon the problem submitted to them, that of determining whether or not the soup made by boiling bones until only their mineral matter remained solid, is or is not a nutritious food for the inmates of hospitals, etc. In the voluminous report which they ultimately submitted to the Academy, they decided in the negative.

Baron Liebig became the popular exponent of their conclusions, and vigorously denounced gelatine, as not merely a worthless article of food, but as loading the system with material that demands wasteful effort for its removal.

The Academicians fed dogs on gelatine alone, and found that they speedily lost flesh, and ultimately died of starvation. A multitude of similar experiments showed that gelatine alone would not support animal life, and hence the conclusion that pure gelatine is worthless as an article of food, and that ordinary soups containing gelatine owed their nutritive value to their other constituents. According to the above-named report and the statements of Liebig, the following, which I find on a wrapper of Liebig's "Extract of Meat," is justifiable: "This extract of meat differs essentially from the gelatinous product obtained from tendons and muscular fiber, inasmuch as it contains eighty per cent of nutritive matter, while the other contains four or five per cent." Here the four or five per cent allowed to exist in the "gelatinous product" (i. e., ordinary kitchen stock or glaze) is attributed to the constituents it contains over and above the pure gelatine.

Subsequent experiments, however, have refuted these conclusions. I must not be tempted to describe them in detail, but only to state the general results, which are, that while animals fed on gelatine-soup, formed into a soft paste with bread, lost flesh and strength rapidly, they recovered their original weight when to this same food only a very small quantity of the sapid and odorous principles of meat were added. Thus, in the experiments of Messrs. Edwards and Balzac, a young dog that had ceased growing, and had lost one fifth of its original weight when fed on the bread and gelatine for thirty days, was next supplied with the same food, but to which was added, twice a day, only two tablespoonfuls of soup made from horse-flesh. There was an increase of weight on the first day, and "in twenty-three days the dog had gained considerably more than its original weight, and was in the enjoyment of vigorous health and strength."

All this difference was due to the savory constituents of the four tablespoonfuls of meat-soup, which soup contained the juices of the flesh, to which, as already stated, its flavor is due.

The inferences drawn by M. Edwards from the whole of his experiments are the following: "1. That gelatine alone is insufficient for alimentation. 2. That, although insufficient, it is not unwholesome. 3. That gelatine contributes to alimentation, and is sufficient to sustain it when it is mixed with a due proportion of other products which would themselves prove insufficient if given alone. 4. That gelatine extracted from bones, being identical with that extracted from other parts—and bones being richer in gelatine than other tissues, and able to afford two thirds of their weight of it—there is an incontestable advantage in making them serve for nutrition in the form of soup, jellies, paste, etc., always, however, taking care to provide a proper admixture of the other principles in which the gelatine-soup is defective. 5. That to render gelatine-soup equal in nutritive and digestible qualities to that prepared from meat alone, it is sufficient *to mix one fourth of meat-soup with three fourths of gelatine-soup;* and that, in fact, no difference is perceptible between soup thus prepared and that made solely from meat. 6. That in preparing soup in this way, the great advantage remains that, while the soup itself is equally nourishing with meat-soup, three fourths of the meat which would be requisite for the latter by the common process of making soup are saved and made useful in another way—as by roasting, etc. 7. That jellies ought always to be associated with some other principles to render them both nutritive and digestible." *

The reader may make a very simple experiment on himself by preparing first a pure gelatine-soup from isinglass, or the prepared gelatine commonly sold, and trying to make a meal of this with bread alone. Its insipidity will be evident with the first spoonful. If he perseveres, it will become not merely insipid, but positively repulsive; and, should he struggle through one meal and then another, without any other food between, he will find it, in the course of time (varying with constitution and previous alimentation), positively nauseous.

Let him now add to it some of Liebig's "Extract of Meat," and he will at once perceive the difference. Here the natural appetite foreshadows the result of continuing the experiment, and points the way to correcting the errors of the Academicians and Baron Liebig. The jellies that we take at evening parties, or the jujubes used as sweetmeats, are flavored with something positive. I have tasted "Blue-Ribbon" jellies that were wretchedly insipid. This was not merely owing to the absence of alcohol, of which very little can remain in such preparations, but rather to the absence of the flavoring ingredients of the sherry. The *Rahat Lakoum*, or "lumps of delight," sold in the streets of Constantinople, is gelatine flavored with the unfermented juices of fruit. A privileged visit which I once made to the monster kitchen of the Old Seraglio of his Majesty the Sultan (at Stamboul) lives perpetually in my memory, so sweetly, so vividly, and so grate-

* London, "Nouveaux Élémens d'Hygiène," second edition, vol. ii, p. 73.

fully, that when I find myself defending the Turk against the Russian and all his other enemies, my conscience sometimes inquires whether those lumps of delight prepared for the Sultana by his Highness the Grand Confectioner, and presented to me by him as a sample of his masterpiece, may, or may not, have ever after influenced my politics. It was gelatine glorified, once tasted never to be forgotten.

It would seem that gelatine alone, although containing the elements required for nutrition, requires something more to render it digestible. We shall probably be not far from the truth if we picture it to the mind as something too smooth, too neutral, too inert, to set the digestive organs at work, and that it therefore requires the addition of a decidedly sapid something that shall make these organs act. I believe that the proper function of the palate is to determine our selection of such materials; that its activity is in direct sympathy with that of all the digestive organs; and that, if we carefully avoid the vitiation of our natural appetites, we have in our mouths, and the nervous apparatus connected therewith, a laboratory that is capable of supplying us with information concerning some of the chemical relations of food which is beyond the grasp of the analytical machinery of the ablest of our scientific chemists.

There is another element of flesh so intimately connected with gelatine and so much like it, that I must describe its properties before going further into the subject of practical cookery of animal food. I refer to *fibrine*, which will form the subject of my next paper.—*Knowledge.*

INSECTIVOROUS PLANTS.

By SALLIE L. ANDREW.

IT was, I think, during the summer of 1876 that Mr. Darwin's most interesting work on "Insectivorous Plants" fell into my hands, and was read with the delight which the "fairy-tales of science" that came from his hand must ever inspire. As a matter of course, I procured, at once, some plants of the *Drosera rotundifolia*, and began a series of amateur experiments, which were to me so interesting that I began to wish all plants might have been created with the same marvelous properties.

While my mind was thus employed, I began to notice that the plants of the common garden *Petunia* (*P. grandiflora*) were almost always quite freely powdered with the dead or apparently dying bodies of small insects, which seemed to be held fast, either by the hairs with which every part of this plant is covered, or by the gummy, sweetish exudations therefrom. I made pilgrimages to other gardens than our own, invariably finding the petunia-plants covered with the small captives.

It was not until the summer of 1881 that I had access to a good microscope, since which time I have spent many hours in trying to penetrate this mystery. In this I have been greatly assisted by my friend Dr. J. H. W. Meyer, who was at first very skeptical in regard to my confident assertions that here was a new insectivorous plant, but who grew more and more interested, and finally became an enthusiastic convert.

Upon our first examination, we found that the hairs—*tentacles* we have learned to call them—varied in length, were somewhat thickened at the base, usually three-celled, the last cell being expanded into a spherical shape. Small protuberances were often found upon the sides of the hairs (Fig. 1), but more commonly upon the bulbous tip. Sometimes these cells seemed to me to have a decidedly spiral form, but of this I could never be quite sure. The tentacles were extremely flexible, sometimes turning sharply backward, as in Fig. 2.

I have made many observations, with a hand-magnifier, upon the plants in the garden. I found the freshly-captured insects most plen-

FIG. 1.

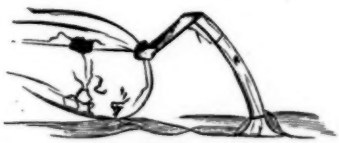


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

tiful about nightfall, at which time the petunia-blossoms emit a powerful odor, and the clamminess of the leaves and stems is most noticeable. I have seen insects as large as the common red ant struggle and die, and have found the horny wings of small *Coleoptera*, but most frequently I have found small spiders, gnats, etc.

When an insect alights upon a leaf (I say leaf, although the hairs upon the stems, calyxes, and even the outer and lower portions of the flower-tubes are quite as vigorous, and as often successful), it at first manifests much alarm, runs with as much strength as possible up and down and under the leaf, lifting its feet with more and more of an effort, until at last, either benumbed or exhausted, its motions are almost imperceptible, and sometimes for an hour will occur at such long intervals that one decides half a dozen times that death must already have taken place. On one occasion, a branch bearing a lively

little insect was cut from the plant, put into water, and the leaf on which the insect was struggling placed under the microscope about six o'clock in the evening, and watched until eleven, by which time life was undoubtedly extinct. During these hours the fight for existence was most interesting, the tentacles one by one discharging their fluid, first by casting drops between the wings—an almost invariable proceeding—thus destroying their usefulness by gumming them firmly together (as in Figs. 3, 4). Then the tips of the tentacles, by this

FIG. 6.

FIG. 7.

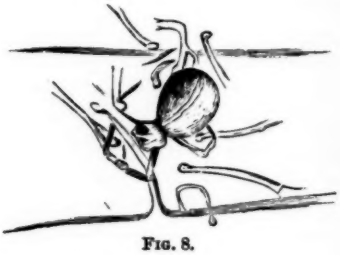


FIG. 8.

time so much excited as to have quite lost their spherical form, are inserted between the joints about the head, and among the hairs of the feet and legs (as in Figs. 5, 6, 7), the stronger members being firmly pinioned by the stronger tentacles (as Fig. 8), while the small hairs are discharging their fluid. This fluid seems to be somewhat tenacious.

Small seeds and bits of sand are sometimes caught in the same manner, but rather daintily, as if the plant merely wished to see if it were worth while or not (as in Fig. 9). I have never seen them *inclosed* by the hairs, as are the animal substances.

FIG. 9.

These are some of the things that I have seen. I do not know what may be the motive of the plant; what it does with the insect, the last stage of whose strange eventful history I have so often seen in a dry, withered carcass, or a few detached and macerated limbs (Fig. 10). I do know, however, that the plant begins its depredatory career as early as the unfolding of the second pair of leaves from the cotyledons, and continues it up to the time of the first frosts.

FIG. 10.

And so, having come to where, for me, the "thus far" ends and the "no farther" begins, I beg to call the attention of those interested in insectivorous plants to the *Petunia*, which fills every waste place in our gardens.

CONSTRUCTIVE ELEMENTS OF THE EAST RIVER BRIDGE.

By F. A. FERNALD.

THE New York Bridge Company, having for its object the building of the suspension-bridge between New York and Brooklyn across the East River, was chartered by the State Legislature April 16, 1867. The work was begun by this company, and continued until its control was transferred to the two cities, June 5, 1874, from which time until the completion of the structure it was carried on by a board of trustees. John A. Roebling was at first chosen chief-engineer, but, dying two years later, he was succeeded by his son and associate, Colonel Washington A. Roebling.

The engineer's plans and estimates were submitted in September, 1867, and were finally approved in the spring of 1869. The mechanical work was begun on the site of the Brooklyn tower January 3, 1870. The finished tower rises 278 feet above high-water mark, and measures from top to foundation 316 feet. It is faced above water with granite, but is built partly of blue limestone. At the water-level the tower is 140 feet wide and 59 feet thick; the roadway passes through it at a height of 119 feet 3 inches by means of two archways each 117 feet high, and 33 feet 9 inches wide at the base. Where this tower stands, the river-bed is a compact conglomerate of clay, sand, and bowlders, in which its foundation rests at a depth of 44½ feet below high-water mark. The lowest course of masonry rests on a layer of pine-beams 15 feet thick, i. e., the roof of the caisson used to carry down the foundation. Under the roof of the caisson are built 72 brick pillars, 9½ feet high, and the rest of the space is filled in with a solid concrete. The Brooklyn tower was finished in May, 1875. The New York tower differs from this in being three feet wider, and in extending down for 78½ feet below high-water mark, where it reaches some spurs of the bed-rock, making the total height of the tower 350 feet. The roof of the caisson was made 22 feet thick, so as to support the greater weight of masonry to be built upon it during its descent. This tower was finished in July, 1876. Neither has as yet settled two inches.

The four cables are each 15¾ inches in diameter, over two thirds of a mile long (3,578½ feet), and each consists of 5,282 galvanized steel wires, not twisted as in a small wire rope, but lying parallel from end to end. No. 7 wire was used, which is a little over one eighth of an inch thick, and each cable was made in nineteen strands. The coils of wire for one strand were spliced together, so that each strand consists of a continuous wire running back and forth across the river, and at each end passing around a grooved piece of iron called a shoe. The

running out and regulating of the wires occupied a year and four months. After the strands of each cable were made, they were united in one bundle, which was wound from end to end with wire. All the wire used had received five coats of oil, and the bundle received another coat before the wrapping; finally, the finished cable was painted with white-lead and oil. Where the cables pass through the tops of the towers, they rest in grooves on iron plates, called saddles, which are 13 feet long, 4 feet 1 inch wide, and 4 feet 3 inches thick in the highest part. The saddles lie lengthwise under the cables, and their tops are rounded so as to afford an easier bearing. Each saddle is supported on 40 wrought-iron rollers, 3½ inches in diameter, which rest in grooves on an iron saddle-plate.

The nineteen shoes, around which the separate strands of a cable are looped, are bolted to as many iron bars, which are 12 feet long, 9 inches wide, and 3 inches thick. These bars are laid side by side in two courses, ten in the lower and nine in the upper. They are bolted to another set of similar bars by means of pins running through eyes in the ends of all the bars in each course. In this way chains of bars are formed, each consisting of ten links, which reach backward and downward to the anchor-plates, both plates and chains being imbedded in the masonry of the anchorage. The anchor-plates are elliptical, star-shaped masses of iron, measuring 17½ by 16 feet. There is a series of holes in the middle of each, through which the last links of the chains are passed and fastened by bolts. Four of these plates lie horizontally beneath and close to the rear wall of each anchorage. The mass of stone which holds these plates down measures 129 by 119 feet at the base, is 89 feet high on the front and 85 feet at the back. The site of the Brooklyn anchorage was dug down to the water-level, and a platform of timber was laid under water, upon which the first course of stone was laid. The soil on the New York side was so loose that piles had to be driven in order to secure a firm foundation.

From the terminus the roadway rises to the top of the anchorage over a series of arches which gradually increase in height. Streets run through some of the archways, under the approaches, and the others are to be fitted up with fronts and floors, and let as warehouses. The length of the New York approach is something over a quarter of a mile (1,562½ feet), that of the Brooklyn approach is 971 feet.

From the anchorages to the towers stretch the landward spans of the bridge, each nearly one fifth of a mile (930 feet) long, while the central span, from tower to tower, measures nearly a third of a mile (1,595½ feet). These three spans are attached to the cables by means of wire ropes. The suspender-ropes vary in length from 170 feet next the towers to 3 feet in the middle of the main span, and each is attached to a wrought-iron band 5 inches wide, which encircles the cable. The band holds a socket into which the end of the suspender is set, and fastened by a pin driven down between the wires, which are

then bent over it, and the socket is filled up with melted lead. Each suspender is tested to sustain 100 tons, but the greatest weight that can come upon any one is 10 tons.

Besides being suspended in this way from the cables, the spans are further secured for 437 feet each way from the towers by stay-ropes, 27 of which start from each saddle-plate, and, spreading out like the sticks of a fan, are attached, at intervals of 15 feet, to the bottom chords of the trusses.

There are six vertical trusses which inclose the five ways into which the roadway is divided. The top chords of the two outer trusses are 9½ feet above the roadway, those of the other four are 16 feet. Each truss has a slip-joint in the middle of each span to allow for expansion and contraction of the structure from heat and cold. For a hundred feet out from the towers these trusses are said to be able to support themselves, not adding their weight to the strain on the cables.

The floor-beams, which lie crosswise, at intervals of 7½ feet, are 86 feet long, and each consists of two sections spliced end to end. To each beam are attached four suspenders, one from each cable, except for 250 feet out from the anchorages, where the cables dip below the roadway, the floor-beams resting on pillars above them, and in the archways of the towers, where the beams rest upon the masonry. The beams are triangular lattice-girders, having a top and a bottom chord connected by vertical posts and diagonal braces. They are 32 inches wide and 9⅜ inches thick. Alternating with these main floor-beams are lighter beams which are fastened to them by cross-ties.

The three spans are protected against lateral swaying by four stays from each corner of each tower, which run out just under the roadway, and are attached to the truss at the opposite side at different distances. Beyond these are other similar stays running from side to side. Further, the two outer cables are drawn inward, and the two inner ones outward, as they recede from the towers, so that each opposes its weight in the form of an arch to lateral movement. The suspenders also tend to prevent swaying, for, instead of descending vertically, each is drawn in toward its half of the bridge.

The total length of the bridge and approaches is over a mile and an eighth (5,989 feet). The middle of the main span is 135 feet above high-water mark, at 90° Fahr. This is sufficient for the bulk of the shipping that uses the East River, but the largest ships have to take down their highest spars to clear it. The cable-wire, trusses, and floor-beams are all of steel, this being the first steel suspension-bridge ever built. The total weight of the suspended portion, including the cables, is 14,680 tons, and the total load that can come upon it is 3,100 tons. To support these 17,780 tons we have the cables, with a united strength of 54,244 tons, and in addition the trusses and stays, which bear no

small part of the weight. Engineer Roebling says that the cables are strong enough to pull up the anchorages, but, as each of these weighs 60,000 tons, they probably will never be called upon to perform that feat.

The roadway on the approaches is 100 feet wide, on the spans 85 feet. The outside avenues are for vehicles, the next two are car-tracks, and a footway 16 feet wide occupies the middle. This latter is paved with asphalt as far as the anchorage, and is only three feet above the driveways. Here it rises by a flight of steps to a plank walk twelve feet above the driveways, from which a clear view over both sides of the bridge can be had. To prevent danger in case the brakes should fail to control a train coming down the incline of the roadway, the car-tracks are kept at the same level for the last 600 feet on each approach, which brings them out at about the level of the elevated roads. The cars are to be propelled by means of an endless wire rope, which will run between the rails of each track, over grooved wheels, set upright 22½ feet apart. Motion is communicated to the rope by two stationary engines located on the Brooklyn side. It is calculated that the cars can take 80,000 passengers across in an hour, that 50,000 more can cross on the promenade, while the driveways will accommodate nearly 1,500 vehicles an hour.

The roadway is lighted by 70 electric lights, set on posts upon the trusses that run between the car-tracks and carriage-ways.

The bridge, which had been fourteen years in building, was formally opened May 24, 1883. Up to April 1st there had been paid out on the work $14,429,003.25, and the expenses then remaining to be met will bring the cost up to nearly $16,000,000. In length of span the Brooklyn Bridge surpasses every other bridge in the world. The span of Roebling's Niagara suspension-bridge is 821 feet, a little more than half as great; the span of the suspension-bridge at Fribourg, built in 1832, the longest in Europe, is 870 feet; while Roebling's Cincinnati bridge, which has the second longest span in the world, measures 1,057 feet between the towers, or about two thirds the length of the East River span.

THE INDUSTRIAL POSITION OF WOMEN.

By EMILY BLACKWELL, M. D.

AMONG all the questions affecting women, and society through women, there is none more vital than that of their industrial position. It is conceded that women should work, but there is a great difference of opinion as to what their work is, and how they should do it. This difference of public opinion is not merely a matter of theory; it leads to very positive practical results, for the support of

public opinion is necessary to make work in any special direction possible.

No one can work independently of others. The training that qualifies for any pursuit, the necessary relations to others engaged in it, the patronage which pays for it—all these are absolutely requisite for its successful prosecution, and these are given or withheld by the force of public opinion. The point at issue in this discussion is, How far can women advantageously take part in the great system of modern industry? Is the effort they are making to enter occupations from which they have hitherto been excluded justifiable? Is it the expression of a real need? Will their success be a benefit or an injury to themselves and to society?

Upon this subject there are two views, the holders of which are endeavoring to enlist on their side this final arbiter of the question, the force of public opinion. On one side it is held that women urgently need greater facilities for work; a wider range of occupations, in order to give them greater power of self-support; that many grave social evils result from this want. It is maintained that the claims accompanying this effort, for equal general and special education, for participation in any kind of work which women feel that they can do, for employment in any occupation for which they have fitted themselves, are just; that the movement is in the direction of progress, and that it is the interest of society to support it. On the other side it is urged that woman has her own peculiar sphere, that of domestic life and work. This, well understood and followed, is sufficient for her. She is unfitted by her physical and mental constitution for the occupations carried on by men. Success in the effort she is making in this direction is impossible. The attempt is leading her to do violence to her own organization, to abandon or slight domestic life, and to become an inferior competitor instead of a companion to man. Progress is to be sought, not by favoring the effort, but by promoting such an extension of home-life as shall render it unnecessary.

Both parties are agreed as to the paramount importance of domestic life. This being admitted, the objection to non-domestic work for women is based upon the implied supposition that, were domestic life as universal as it should be, the domestic work connected with it would be sufficient to absorb the great body of women-workers.

To estimate the force of this objection, let us consider what is meant by the terms domestic life and domestic work. There are two elements in the domestic position of women: first, their personal relation to the family as wives and mothers; secondly, the work which necessarily devolves upon them in the fulfillment of the duties of these relations. The first, the personal relation, is a fixed and constant element. It grows out of the constitution of human beings, and exists under every form of society. It attains its highest expression wherever the union of one man and one woman is the foundation of the family.

Here we find most marked the personal affection, the intimate companionship, the community of interests, the common responsibility and care for the children, which are the characteristics of the family. The related life of the group so formed constitutes domestic life. But if the personal relations of woman to the family are thus fixed and enduring, her industrial relation to it is by no means so unchanging. The work which she must do for it varies according to external conditions. There is no one kind of work which absolutely belongs to domestic life; there is hardly any kind of work that has not in some phase of society been considered to belong to it.

In the savage state, women built the wigwam, raised the corn, prepared the clothes, carried on in its rudest and most elementary form all the work which is to-day the object of modern industry. But since these simple forms of labor have developed into architecture and agriculture and manufactures, it is held that women can not follow their old occupations under their new forms, under penalty of personal deterioration and social disaster. It is the conditions under which work is done, apparently, which constitute it domestic work, rather than the nature of the work itself. Weaving was domestic work when done at home, but ceased to be so when done in a factory.

Domestic work, therefore, is all work for the family which, under our present arrangements, must be done at home, upon a small scale, by individual workers, free from the organization and competition of business. Precisely in the degree that outside occupations partake of any of these characteristics of domestic work, are they considered appropriate to women. On the other hand, how feminine soever the nature of a work, as soon as it is seized upon by the modern system of outside labor, begins to be carried on upon a large scale, and to be subject to the laws of business competition, it thenceforth ceases to belong to women. It has departed from the conditions of domestic work.

If this definition of domestic work be correct, two questions naturally arise in connection with it: 1. Will the work now done at home always continue to be so done? 2. If the conditions of domestic work are those most favorable to the well-being of women, what is the reason of their growing distaste for domestic service? The answers to these two questions are very closely connected with each other, and with the main question of the industrial position of women.

When we consider, on one hand, how pressing and increasing an evil is the lack of skillful and reliable servants, how severely the want of efficient service weighs upon the mothers of families, and, on the other hand, how liberal is the compensation and how certain the employment for women having even a moderate degree of skill in housework, there seems, at first sight, some truth in the assertion that the difficulty with women is not the want of work, but the inclination to shirk their own work in order to invade that of men. The complaint

of the difficulty incident to finding well-paid work does not come from our domestic servants. The Irish girl finds work from the day of her landing. and begins almost immediately to send remittances of money to her friends at home. The American girl, thrown upon her own resources, struggles miserably to keep soul and body together upon the scanty wages of the shop or the factory. Yet so decided is the disinclination to domestic service, the largest and most profitable field for women to work, that American women have virtually abandoned it. The Irish girls gradually absorb the same distaste, and are less available as they become Americanized. We already hear the suggestion in favor of the Chinese, that they are needed to supplant the Irish servants, as the Irish have taken the place of Americans.

Is not the cause of this dislike to be found in the servile nature of domestic service, which renders it necessary to bring in a constant succession of servile labor to fill it? Is it not just in proportion as women rise above the servile tone of feeling that they become restive in the position, and will sacrifice comfort and pecuniary advantage to escape from it? Almost every feature of domestic service partakes of this repellent character. On entering it, the woman, like the slave, drops the surname which marks her as a member of a family of a social connection, for the personal name which sinks her at once into a rank below that in which social connection is recognized. Reversing the natural order of things, the woman addresses the children and young men of the family by terms of respect implying superiority, while they address her by the familiar name implying inferiority. She abandons family life, having no daily intercourse with her relatives as do out-door workers living in their own homes. She loses her personal freedom, for she is always under the authority of her employer. She can never leave the house without permission; there is no hour of the day in which she is not at the bidding of her mistress; there is no time in her life, except the few stated seasons of absence, for which she may not be called to account. Though her accommodations are probably far better than she would have at home, their relative inferiority renders them less acceptable than the poorer quarters in which she shares freely the best there is to have. Every distinction of dress which is a badge of domestic service is universally felt to be derogatory. It is creditable to a man to refuse any domestic position that entails the wearing of a livery, while the uniform of even the lowest ranks of the public service—of the policeman or the postman—is assumed with satisfaction. The white cap and apron that become almost a uniform when worn by the graduates of the training-schools for nurses, as the mark of a superior class, are assumed with reluctance as an accompaniment of domestic service.

Precisely in the degree in which house-work has this character it is shunned. When American women do engage in domestic work out of their own families, it is not the easiest and best-paid positions which

they prefer. They are not to be found as nurses, seamstresses, and chambermaids in wealthy families, but rather as the sole workers in small and simple country families, where they have the kitchen to themselves, and the contrast between the social position of themselves and their employers is not so great.

In all such matters feeling is quicker than reason. Every woman instinctively feels that, in exchanging the position of an outside worker for that of domestic service, she descends one step in the social scale, and approaches one degree nearer to personal servitude. Upon what does this servile nature of domestic service depend? It is not due simply to difference of wealth and social standing; that difference exists everywhere between the employer and the employed. It is due to the conditions under which the work is done in the house, each servant dependent upon the mistress in the details of her personal life, doing work more or less undefined in its nature, amount, and time of doing. These conditions imply a direct, perpetual, personal subordination, necessarily servile. It is the absence of these conditions that renders non-domestic work independent, instead of servile. The limitation of the work within certain hours, outside of which all subordination or accountability to the employer ceases, the freedom of personal life thus gained, the more defined nature of the work, its larger scale, the numerous workers engaged in it—all these characteristics render the relation between employer and employed a business, not a personal one.

We can only imagine the servile character absent from domestic service in a state of society so simple and homogeneous that the work of each family was done by its own women; and one in which there were so few women not required at home that they could be absorbed by those families in which there was a paucity of women, and there work upon an equal footing with the wives and daughters. Is there anything in the tendencies of modern life pointing to such a state of society? Are they not sweeping us in an entirely different direction? Would it not be more in accordance with the forces shaping modern life to suppose that the problem of domestic service will be solved rather by changing the mode in which domestic work is done, than the relative position of mistress and servant? Will not such a change be the natural result of a continuance of the process which has already transferred one occupation after another from the sphere of domestic work to that of business organization? Is it not inevitable that all the material arrangements of life shall ultimately thus be taken possession of?

There is no reason why what is now done by domestic service should always continue to be so done. As weaving and tailoring have gone, so the making of women's and children's clothing is now going. There is no reason inherent in the nature of things why washing, cooking, mending, etc., should not go also, and be done by business organiza-

tions from outside, instead of by domestic service. Thus domestic work will be reduced to the minimum, to that part most intimately connected with the personal life of the family. The need of domestic service will diminish in the same proportion, and the problem it presents will be solved by its diminution, or gradual disappearance; while domestic life will be more and more freed from the necessity of carrying on a variety of domestic work.

The obstacles to be overcome in bringing about this result do not differ in kind from those which are disappearing elsewhere before the ingenuity and perseverance of business enterprise. The difficulties in the way of supplying cooked instead of raw food are very similar to those being now overcome in the transport of delicate and perishable food, and in the preserving such food in perfection through the whole year. There is no reason why bakers should necessarily supply inferior bread, or why cooking done on a large scale should always be inferior to that done at home. That the work which remains to be so dealt with is the most difficult to be thus treated is the reason it has remained to the last. That our efforts in this direction are as yet attended by imperfect success is no proof that this will always be the case. Until business organization has advanced so far as to do the work as well as the same can be done at home, and more conveniently and cheaply, its imperfection will keep up our present system of domestic service.

It may be objected that so radical a change in the conditions of household work must imply the destruction of the home as we at present understand it. But why should this be the result of the changes to come, any more than of the equally great changes that have been already accomplished? The dread of it arises from the same sort of feeling which has made it so difficult for geologists to accept the fact that the wonderful changes recorded upon the surface of the earth have been accomplished by the same agencies which are at work upon it to-day, so silently as to be imperceptible to the multitude.

It may be objected that the failure to marry is the reason so many women are seeking employment; and that, were marriage sufficiently universal, the immense majority of women would be occupied in their own homes. Facts do not seem to bear out this view. The proportion of persons who pass through life unmarried is comparatively small. The mass of working-women is composed not of middle-aged single women, to whom alone the criticism could refer that they have preferred other work to marriage. The great bulk is composed of young women under twenty-five, whose families can not afford to support them for the sake of their domestic work, and the majority of these will probably eventually marry. There is also a considerable number of married women who, by the death or inability of the husband, are thrown back upon the necessity of self-support. This last is a much larger class than is usually supposed. It would probably at least equal

the number of single women of corresponding age—that is, of women who have remained single to middle life.

As a matter of fact, support through marriage can not be co-extensive with the need of support for women. It does not cover the whole period of working-life, and it fails to be a support in a considerable proportion of cases.

It would seem that there must be a fallacy in the view that would make the natural provision for honorable and satisfactory support depend upon a relation that does not cover the whole need in any case, and can not be certainly counted upon in any individual case. The same tendency toward complexity of conditions and relations, which makes equality in domestic service a thing of the past rather than of the future, would lead us to anticipate that the number of women workers must increase rather than diminish. In taking methods for improving their condition we must look forward rather than backward, to means which are in harmony with influences now at work, rather than to such as would require a return of conditions which have passed away.

We believe, therefore, that a careful consideration of the movements which have gone on and are going on in social life leads to the following conclusions:

1. There is no necessary connection between domestic life and domestic work.

2. Domestic life means the united life of the members of a family, and is a constant social element.

3. Most of the work now done as domestic work is only so done because it has not yet been brought within the grasp of business organization. The range of such work is constantly growing narrower.

4. Our method of doing it by domestic service is imperfect, because domestic service involves a servile relation that does not exist in non-domestic labor.

But if all work tends thus irresistibly to become organized into departments of business, the question of the future industrial position of women is settled. They must follow their work under its new forms, or cease to work at all. Extremes meet, and the organization of industry must end by giving back to women what it began by taking from them, a place in the varied work of the world.

So far from the perfection of domestic life being imperiled by the gradual substitution of non-domestic for domestic labor, many advantages would be thereby gained:

1. It would help to free marriage from any but personal considerations. The question as to the capacity of a woman for house-work would become as foreign to that of her desirability as a wife as is now her ability as a tailor. It would be a wife only, not also a domestic, that the young man would need to seek.

Still more important a change would it be were marriage, to women, only the entrance into a wider and happier social state, and need never be regarded as the only recognized business opening.

2. It would bring more varied ability to the service of domestic life. Despite the many kinds of work which have been gradually taken out of the housekeeper's hands, her position still calls for a variety of faculties rarely combined in one woman; and household life is in most families correspondingly imperfect. The business ability that makes a good housekeeper, in the sense of a good provider for material needs, of a capacity to use money to advantage, and to secure order and perfection of work, is one thing. To be a good educator, to possess the faculty of understanding and training children, is another. Neither of these qualifications is necessarily connected with the gifts and tastes which are required to make the home a social center, to bring its inmates into the friendly and easy relations to other families upon which its social standing depends, and which, under the present state of things, are so essential to the welfare of its young people as they approach the age for marriage. The mother of a family, whether rich or poor, must be a sort of "Jack of all trades," and often goes through life with the discouraging sense that, in one or other of these important departments, her good intentions will never supply the lack of natural faculty. The less complicated and extensive the work that necessarily devolves upon a woman in her household, the more chance for its successful accomplishment. The more she can call upon skillful help, the less likely the family will be to suffer from her deficiency in any direction.

There is nothing which would seem more absolutely dependent upon the mother than the care and training of very young children. Yet the careful study of the best modes of training these early years, which has come in with the Kindergarten, shows how far the nursery alone is from meeting their needs; how early and how much skilled teachers, other children, a variety of apparatus, that is, outside help, are desirable for the best interests of the child, as well as for the assistance of the mother.

3. Another great advantage that would come from a general recognition that the occupation of women in non-domestic work tends inevitably to increase, would be the impulse it would give to the industrial training of girls. Parents do not think it worth while to educate their daughters for any pursuit, because they consider industrial occupation for a girl an undesirable exception, not to be provided for. An immense amount of misery would be avoided did custom require that every girl should be taught some paying work. It should be considered more obligatory in the case of girls than of boys, thus to guarantee them the possibility of independence, both because they are less able to make opportunities for themselves when unexpectedly called upon to do so, and because of the greater dangers to which helpless-

ness exposes them. There is no greater source of suffering and vice among women than the fallacy of taking for granted that they will not need to support themselves.

4. The wider the range of occupations for women, the more numerous will be the points at which the lives of men and women touch. One of the objects to be accomplished by advancing civilization is the bringing of men and women into easy and natural companionship. Under existing circumstances almost the only meeting-ground for young men and women is in society. Those who can not take an active part in this are almost shut off from acquaintance with the opposite sex. Numbers of girls educated at girls' schools, and afterward living at home in narrow circumstances, or going into work conducted by and among women, remain single because they pass the age for marriage without sufficient opportunity for meeting men of their own standing, or make unsatisfactory marriages, because they do not choose from knowledge, but accept the only opportunity that offers. The same is true of young men not in society. Their life is passed almost exclusively among men from their school-days upward. Their acquaintance with women of their own age is extremely limited and superficial. The more complete the separation of men and women in work, the more must this division in life be the result. The more numerous the common interests and occupations in which they meet in recognized and honorable companionship, the more numerous the chances for suitable and happy marriage. So far, therefore, from deploring the encroachments of business organization on domestic work as a danger to the happiness of domestic life, we should see in them an agency which will lead to its higher development.

But if, as we have shown, it be in the natural course of things for women to take part in industrial pursuits, what is the meaning of the warning notes that attend their steps in that direction? We are told that women break down under the strain of college education; that their health gives way under the requirements of book-keeping, telegraphy, factory-work, every kind of business; that their work is poor and unreliable, and will command only starvation wages, etc., and these discouraging reports come not only from illiberal opponents, but from sincere friends and well-wishers. The most important of these objections is based upon the assumption that the physical constitution of women unfits them for safely bearing the strain of brain-work or business.

It is true that the health of women is not what it should be; but the cause of this lies neither in their peculiar organization nor in their efforts in new directions. It is to be found in the influences surrounding them from infancy, which prevent our girls from acquiring the physical vigor which should accompany maturity. This defective health is nowhere shown more conspicuously than in domestic life. Nowhere do women break down more frequently and completely than

in the bearing and rearing of children, under the strain of maternity, and the wear and tear of domestic duty.

It is not only, nor chiefly, our college graduates and industrial workers who crowd the offices of specialists, and the same department in our charities. The girls who stay at home and are subjected to no educational strain, the wives and mothers who are pursuing the most natural of avocations, are quite as fully represented. We must believe that it is the physical education, not the organization, of women that is at fault, unless we accept the conclusion that the special constitution that is supposed to disqualify them for other work disqualifies them also for its own ends.

It is generally assumed that the women who have broken down in outside work would not have done so in married life, but it is precisely the feeble health that fails in one that fails in the other also. There is a general inclination to compare the results of work under unfavorable conditions with those of married life under favorable ones. If we compare the health of the same class of women, under equally favorable or unfavorable conditions of work or of married life, it is extremely doubtful if the result would be as much in favor of the latter as the opponents of non-domestic work for women take for granted.

Many of the difficulties which now embarrass women in work are such as belong to a transition state. They will disappear as the presence of women in these new fields is accepted and provided for. The fewness of the occupations open to women and their consequent overcrowding; the difficulty, often the impossibility, of acquiring special education for occupations in which special skill is required; the opposition of the workers already in the field—these are only a few of the obstacles which are due to the novelty of the effort. Business has been arranged to suit men; and women, upon entering any new branch of labor, are required to accept its existing conditions. There are many kinds of work which women could do perfectly well if they could modify these conditions. But if, without this, they fail to do it as well as men, or suffer more in doing it, it is taken for granted that the work is unfit for them, that the remedy is to exclude them from it, not to adopt the mode of doing it to their requirements.

As an illustration of the different effect of the same work according to the circumstances under which it is done, take agricultural labor. Nothing is more frequently quoted as an exemplification of the brutalizing effect of masculine work upon women, than the results of field-labor as it is carried on by them in some parts of Germany and other places, where women are considered, and treated, as mere drudges. Contrast with these reports the following statements in regard to the effect of field-work upon women in the north of England, extracted from the "First Report of the Commissioners on the Employment of Children, Young Persons, and Women in Agri-

culture," presented to Parliament in 1868. In it Mr. Henley states that the women who work in the fields of Northumberland are "physically a splendid race." The same witness says: "There are many who consider field-work degrading; I should be glad if they would visit these women in their own homes, after they have become wives and mothers. They would be received with a natural courtesy and good manners that would astonish them. . . . The visitor will leave the cottage with the conviction that field-work has no degrading effect, but that he has been in the presence of a thoughtful, contented, unselfish woman. . . . The very appearance of the habitual workers is sufficient to prove the healthiness of their mode of life; and the medical testimony is overwhelming as to the absence of disease and the usual complaints attendant on debility."

Mr. John Grey testifies of the same women: "The healthful and cheerful appearance of the girls in the hay or turnip fields of the north, and their substantial dress, would compare favorably with those of any class of female operatives in the kingdom," etc. Here we have the same kind of work, destructive in one case, beneficial in the other. And this is due to the different conditions under which it is done. So in other work, it is not necessary that women should do every part of it precisely as men do it. The question is, Is there not in most kinds of work a place which women can fill to advantage under suitable conditions?

Women are much more fettered than men by conventional requirements and prohibitions. They come to any new occupation hampered by the restraints and burdens so imposed. Their dress is modeled upon fashions adopted by women in society, to whom dress is a profession, occupying a great part of their time, strength, and intelligence; yet custom forbids any material modification of it to suit the requirements of work. Equally liable to misrepresentation is any assumption of unconventional freedom in going about, ways of living, etc. Women are hindered at every turn by endless restraint in endless minor details of habit, custom, etc., which, often trivial in themselves, by their number and perpetual action often trammel them as effectually as the threads of his Lilliputian adversaries did Gulliver. In these respects we might apply to men and women the common French saying in respect to English and French law, viz., that "to one everything is permitted that is not expressly forbidden, to the other everything is forbidden which is not expressly allowed." Most women who have been engaged in any new departure would testify that the difficulties of the undertaking lay far more in these artificial hindrances and burdens than in their own health, or in the nature of the work itself.

Finally, is not much of the objection that work is destructive to the workers applicable to all work and all workers—to men as well as to women—to domestic as well as non-domestic work? Do we

not hear on all sides the complaint that, from the highest forms of brain-work to the lowest forms of hand-work, the strain requisite for success breaks down prematurely those who follow them? Is not the choice, too often, virtually between immediate death from want, or a more gradual and protracted death from overwork, or the unhealthy conditions of work?

Our organization of labor is exceedingly one-sided and imperfect. It is directed almost exclusively to the advancement of the work, without any reference to the welfare of the worker. We have a long way to go before we can be rid of the most crying evils of our present state.

It is only too evident that we have not yet solved the most fundamental problems in regard to labor, when we see such glaring contradictions as produce spoiling in the fields because there is no market for it, and mills stopping work because the market is over-supplied, when at the same time thousands are suffering from want of food and clothes. So long as the relations between workers and work are so imperfect, the hardships thus entailed must fall upon women as well as upon men.

One of the first requisites for improvement is to know the direction in which effort should be made. We must learn to distinguish the movement of the tide from the eddy caused by resistance to its advance. One of the greatest difficulties in the way of freedom of work for women will be removed when once it is recognized that in this direction is the onward movement of the current, however turbid it may be from the obstacles that disturb its course.

AFRICAN PSYCHOLOGY.

By MAX BUCHNER.

ALL of those parts of South Africa which are under the dominion of the Bantu race are ethnographically so homogeneous that the essential facts that may be stated of one tribe apply almost exactly to all, and the differences in dress, stature, color of the skin, utensils and weapons, ornaments, customs, and ideas, which are produced by external and different temporary, not local, changes only, are limited in every case by the same lines. Many of the photographs brought by my friend and colleague Buchta from the Egyptian Soodan might as well have come from the territory I explored, diagonally opposite to it. The language of King Mtesa's Waganda has the same grammatical structure as that of the Angolese, and the vocabularies of both people have numerous similar words.

The negro in his native condition is not apparently of a lower grade of natural intelligence than the European of the common class. He probably excels the European in a kind of selfish cunning, while the restraint of moral scruples and of the finer feelings operates less strongly upon him. Yet he is not destitute of a sort of moral instinct, of a kind of taboo-conscience, that causes him to hesitate to do wrong. If he can not resist the temptation, he resorts to sophistics to give himself an apparent justification. This is a remarkably well-developed trait in his character. For this reason the negro is never an open thief, but will always seek or make an excuse, under the operation of which his robbery may be caused to appear in the light of a reparation made to him. Of such character are the numerous *milongas* which play so great a part in the life of the traveling trader, the name of which, a much-used word of unpleasant sound, combines in itself various equivocal ideas of criminal process, liability to penalties, oppression, and a great clamor. As an example of the *milonga*, we may notice a favorite trick among several of the tribes of sending their women into the camps of passing traders to tempt their members by coquettish behavior. On the slightest occasion, the men, who have been watching, rush in in a threatening way, and demand a quantity of goods as a recompense for the affront that has been offered them. The trader has to satisfy them, for he has not force enough to resist them. Another trick is to leave manioc-roots or baskets of grain in the road, where the hungry travelers may be prompted to take them up, when a similar scene of surprise and extortion will be enacted.

The negro is above everything positivist, practical, and materialist, and is inaccessible to intangible considerations. He is not, it is true, destitute of a sense of beauty, and has a word for the idea. But although, other conditions being the same, he will prefer a handsome woman to an ugly one, he is always moved by practical views in his choice. With this practicality is associated the persistent propensity toward falsehood that makes the traveler's way so hard. Hunger and thirst, heat and cold, fever and privation have, I confess, often proved less wearing upon me than the impossibility of ascertaining a fact by means of direct questioning; and I have frequently, in my vain struggles after clear information, been tempted to anathematize language as a tool of error. In indifferent matters the negro will say the first thing that occurs to him, because that is the easiest; in matters that touch his interest, such as the value of anything he may have for sale, no reply will suit him better than a false one. To these two incentives to lying—indifference and cunning—is added a third, the sense of the comic which much questioning arouses within him. Some traders are able to enjoy the stories the blacks tell under such circumstances; and they are perhaps harmless, unless the traveler puts them into his note-book and prints them for truth. The negro's moods are cheerful and wanton, superficial and changeable. Passion and hysterical anger are

not uncommon, but they pass away as suddenly as they come on. Lasting friendships are not known. Relations apparently the closest are suddenly broken up or changed into enmity by the most insignificant causes.

Melancholy tones can hardly be attributed to the negro spirit, and I would have averred that suicide was inconceivable among them, had I not learned from trustworthy sources that instances of it had occurred. These were, however, only among more nearly civilized individuals. The ruling passions of the race concern the gratification of pleasure and greed for property. The most serious troubles originate in these spheres. The theft of a goat will afford a chief a more ready provocation for war than a box on the ear. The ideas of honor and manliness are almost wholly wanting, at least among the common men. Blows are unpleasant to them only in so far as they cause pain. They will bear the cuffs of their lord with resignation and as matters of course, as a part of the contract, while they will most likely toward strangers put themselves timidly and passively in an attitude of defense.

The question, "Has the negro a religion?" can not be answered at once either affirmatively or negatively. It must first be made clear what is to be understood by religion. If it be defined as a system of conceptions, aspirations, hopes, and apprehensions, and the moral precepts suggested by their operation, then the negro has no religion. If we call a confused mixture of vague wants and superstitious impulses a religion, then he has one. We might, perhaps, say more correctly that the common human weaknesses which are among ordinary motives of religion—feelings of anxiety, longings, illusions, fancies, and the corresponding efforts to get light—are not wanting in the negro, but he lacks the deep reflective power to build up a symmetrical structure out of his theological raw material. As the negro is in the habit of dreaming of his dead relatives, and is very apt to imagine that this or that dead person allows him no rest in the night, and must be silenced by propitiatory offerings, he is not very far from believing in the immortality of the soul. I have frequently inquired of the most intelligent blacks under my command, of those who had been baptized and considered themselves Christians, what they thought of their future after death, and have never received any other answer than that "then life will be at an end, and we shall be buried in the ground and eaten by worms."

They have a word, *nsambi*, which might be translated by "God." The following are examples of the way it is used: *Diulee dia nsambi*, God's sky; *Kalunga ka nsambi*, God's sea; *dikembi dia nsambi*, God's sun; *dikua dia nsambi*, God's axe—the name of a grass that cuts very badly; the name *nsambi* is also applied to the *mantis*, or praying insect. Personally and practically however, this *nsambi*, as my Augustus once told me, is of no interest to the negroes. He does them

neither good nor harm, and troubles himself only about the whites, who owe their skill and wealth to him.

The woods and fields, however, are supposed to be inhabited by numerous sprites which go out to trouble and vex the blacks, never doing them any good, but are at their best when they are satisfied to be harmless. The dead are regarded as in the same position as toward the living. A third, still more dangerous class of hostile powers, consists of the wicked enchanters among the black's own neighbors, with whom he is in daily intercourse. The magicians are also capable of doing harm to the whites, while the genii and spirits of the dead are not. All sickness, all loss in business, every misfortune, even strokes of lightning, are referred to one or another of these evil influences. The religious aspirations and ritual of the Bantu relate chiefly to provisions against these three negative principles. Among the defenses against evil are oracles, medicine-men, and prayer. The technic of the oracle, the duties relating to which are generally performed by some person who has gained a repute for skill in the art, is extremely childish and ridiculous, and depends upon the crudest and most palpable deception. A favorite method of managing it is to take a piece of board with a smooth groove cut upon it. The oracle-priest rubs a stick back and forth in the groove, all the time asking, if, for instance, the object is to discover who has been guilty of some trespass or witchery: "Was it the Shamuhongo?" "Was it Joao?" and so on. All at once the stick will stop and refuse to slide any more in the groove. The person whose name has just been pronounced when this happens is the guilty individual. None of the by-standers will have any doubt on the subject; for, it is fair to remark, the priest has generally previously taken care to inform himself of the state of public opinion in the matter. Men's lives are frequently risked by these experiments; for the person who is accused in them has afterward to undergo the ordeal of poison. Another method is for the oracle-priest and the person consulting the oracle to take a position in the open air and both grasp with their right hands the handle of an axe which has been placed upright on the ground, the questioner's hand uppermost. The questioner tries with all his might to hold the axe fast to the ground, the oracle-man exerts his strength to lift it up. The answer is given when the axe sticks so fast to the ground that it can not be moved at all. The fear which prevails and is generally quite strong, of being accused by some of the oracles, has a beneficial effect in restraining malicious mischief and promoting peaceableness.

Of the two chief motives of European prayer—the fervor of devotion and the strength of desire—the negro is acquainted only with the latter, or selfish one. He has a kind of instinctive, unconscious idea that he may attain his wish by giving it constant utterance, and every other higher blossoming of religious wants is strange to him. Prayer is made with a sort of litany, in which the praying-master, swinging

a kind of a rattle, utters some appropriate sentence, while the petitioner repeats it in unison with him. Particularly well-trained praying-masters deliver themselves of the prayer in a high falsetto, which appears to them to have a more insinuating, and therefore more effective, sound. There is no real priest class. There are negroes accustomed to daily religious exercises, like devotees among us ; but of earnestness and devotion, in the sense in which we understand those terms, not a trace can be observed. The cheerfulness of the negro temperament is never suppressed. If a person happens to come upon any of their religious exercises, and betrays an expression of amusement, the whole company of worshipers will break out into laughter, and be glad that their demeanor has been found so pleasing. Aside from the fear of wicked fetiches, which is a great source of trouble, and from the pleasure of trading, which occasionally carries him hither and thither, the life of the negro passes with a uniform freedom from care. He is born, brought up, takes a wife, begets offspring, grows old, and dies, without having undergone any training, gone to school, had to choose a calling, or been subject to any other kind of anxiety. He has no regularly recurring festivals ; but the revelries on the occasion of a death in the connection or in the circle of neighbors and friends are often protracted through many days or even weeks. How many years old he is he neither knows nor cares.

A system for computing time can hardly be predicated of such a people ; but they have a kind of superficial calendar of the months, which they make to help regulate their agricultural operations. The Angola negroes count the moons during the period of cultivation, and indicate them by numbers from one to ten. During the dry season, when agriculture is dormant, the calendar also is asleep. In August, when the distant lightning announces the approach of the rainy season, the women start out to clear the fields for the crops ; and, as soon as the ground has been wet by the first rains, they plant their ground-nuts. The moon in which this is done is the first. The divisions of the day are measured off according to the place of the sun in the sky.

The often asked and variously answered question of the capacity of the negro for civilization applies in an equal degree to him and to all other savage people. It arises more frequently with respect to the negro, only because the attention of philanthropic men has been more prominently directed to him. It must be answered in his favor. The negro undoubtedly possesses all the capacity for education and civilization to at least as great an extent as our primitive ancestors had it. But, just as our ancestors could not at once and immediately emerge from barbarism into our present conditions of many-sided development and refinement, so we have no reason to expect that the African savages can, in one or two generations, reach the standard of modern

Europeans. The fact that the psychical and intellectual, as well as the physical, differences between particular races of men are really insignificant, is destined to be made more plain the more the subject is impartially studied, and the efforts of certain men, learned in distinctions of types, to set up fixed marks of separation between them, will not succeed.—*Translated for the Popular Science Monthly from "Das Ausland."*

SKETCH OF DR. WILLIAM FARR.

DR. WILLIAM FARR, who died on the 14th of April last, aged seventy-six, was the founder of the English system of vital statistics, and was chiefly instrumental in bringing it to its present state of perfection; and, in the measure that the study of the statistical tables has furnished facts for the guidance of sanitary officers, he may be said to have contributed directly and very greatly to the improvement that took place in the public health conditions of Great Britain during his career.

Dr. FARR was born at Kenley, Shropshire, England, in 1807. He went to school at Dorrington and Shrewsbury, then entered upon a university course in Paris, and concluded his studies in the University of London, in 1831. He served for six months as house-surgeon of Shrewsbury Infirmary, subsequently began the practice and teaching of medicine in London, and afterward edited for some time the "Medical Annual" and the "British Annals of Medicine." In this work he exhibited a power of statistical analysis that attracted the attention of the proprietor of the "Lancet," and he became a constant and valued contributor to that journal, of articles dealing chiefly with vital and medical statistics. He thus acquired a reputation in this line of work, which induced his selection by the Government, in 1838, as compiler of abstracts in the newly-created office of the Registrar-General of Births, Deaths, and Marriages. An act of Parliament was passed directing that a statement of the cause of death should be inserted in connection with the registry of the fact, and Dr. Farr was assigned this work specifically on account of his known capacity for statistically analyzing the materials that would come under his eye; the registrar-general stating in his first report that the assignment had been made to him as "a gentleman of the medical profession, whose scientific knowledge and intimate acquaintance with statistical inquiries were ample pledges of his peculiar fitness." For forty years in succession Dr. Farr's reports of his analyses were presented to the registrar-general to form one of the most important parts of his reports, and were the medium for contributing facts, the practical ap-

plicability and permanent value of which became every year more evident. Of these reports, as a whole, the registrar-general says in his report for 1879: "To his scientific researches and reports I attribute any reputation that may have accrued to the General Register Office of England and Wales from the time he accepted office in this department." Besides these letters, many special and supplementary reports were contributed by Dr. Farr to the publications issued by the registrar-general. Among them were the "English Life Tables," the first, for 1841, based upon the deaths in all of England and Wales for that year; and the second, for 1844, on the mortality of the seven preceding years; while the third, for 1854, on the seventeen preceding years, was published as a distinct work, prepared by direction of the Government for use as the basis of the post-office insurance system. In 1852 he published a report on the cholera epidemic of 1848–'49; and, in connection with the twenty-ninth annual report of his chief, a report on the cholera epidemic of 1866. Of special value also were his decennial reports on the English mortality statistics of the three decades, 1841–'50, 1851–'60, and 1861–'70, the last of which, says the "Lancet," "especially is a mine of statistical wealth, not only as a treasury of well-arranged and analyzed facts, but as suggestive of fruitful fields for future investigation."

Dr. Farr was appointed an assistant commissioner under the direction of the registrar-general for taking the censuses of 1851, 1861, and 1871; did valuable service in statistically organizing and superintending each of the enumerations, and wrote the greater part of each of the three reports. He was one of the earliest members of the Statistical Society, and was for forty-two years a member of its council, its treasurer for twelve years, and its president in 1871 and 1872. His papers to this society have been pronounced by Mr. Leoni Levi, also an eminent statistician, "replete with facts, rich with mathematical lore, and remarkable for close reasoning," but never dry; and his work was invariably marked by a distinct and due regard to practical results. He was an early and valued supporter of the British Association, the British Medical Association, and the Social Science Association, in the proceedings of all of which bodies papers by him may be found, and was largely instrumental in the formation of the Section of Statistics and Economical Science in the British Association.

Dr. Farr served the state on a large number of royal commissions and parliamentary committees on sanitary and other subjects, in the work of which his special attainments, his familiarity with statistics relating to them, and his mathematical skill, made his assistance desirable, and sometimes indispensable. Among the special subjects with which he was thus at one time or another engaged, were army medical statistics, the health of the army in India, the condition of mines in Great Britain, water-supply, public health, and police super-

annuation. On all these matters, when called upon, he gave his services cheerfully, and did thorough work. He was present as a representative of Great Britain at the several statistical congresses which have been held at intervals in the various capitals of Europe since the custom was begun, in 1851. At the Statistical Congress held at the Hague in 1869, he made a report upon coinage and metric weights and measures, in which was embodied a recommendation for an international system of metric coinage, with a strong argument in its favor.

"The forty years of Dr. Farr's life preceding his retirement from the public service in 1879," says the "Lancet," "were spent in unremitting statistical labor. It is impossible to doubt either the value of his work, or of its influence upon public opinion in health matters, preparing the way for and making possible the sanitary legislation of 1872 and 1875, which is already so favorably influencing the health and longevity of the English people. We know, however, of no complete list of his contributions to statistical literature." Besides the papers already mentioned in this sketch, we find, referred to in articles of which he is the subject, a paper in the "Lancet" "On Benevolent Funds and Life Assurance in Health and Sickness"; a pamphlet describing a system of Government life assurance; a paper in the "Transactions of the Royal Society" on the "Construction of Life Tables"; the article on "Vital Statistics" in McCulloch's "Statistics of the British Empire"; and papers on the "Finance of Life Insurance," the "Income Tax," the "Valuation of Railways," and the "Valuation of Railways, Telegraphs, Water Companies, Canals, and other Commercial Concerns, with Prospective, Deferred, Increasing, Decreasing, or Terminary Profits." The language of his papers was always characterized by lucidity, simplicity, and common sense, and, notwithstanding the supposed aridity of the subjects, often rose into eloquence and impressive presentation; and his influence on public opinion in health matters is believed by the "Lancet" to have been "in great measure due to his picturesque style of writing, which invested dry facts with popular interest, although it laid him open at times to depreciatory criticism from those who believe that the style of statistical literature and reports should be characterized by the soberest dryness."

In 1879 Major Graham, the registrar-general, Dr. Farr's superior, resigned his office. Public opinion indicated Dr. Farr as his legitimate and only fitting successor; but the Government overlooked the principle of civil-service selection and appointed another person, who was not known to have any special qualifications for the trust. Dr. Farr therefore wrote to Major Graham a letter of resignation of his own position, saying: "Having learned from you that Sir Brydges Henniker is to be the new registrar-general, and thus having lost all chance of being your successor, I shall be glad if the Lords of her Majesty's Treasury will allow me to resign my appointment, and will

grant me superannuation allowance to the extent of my full pay. I have served under you nearly forty years, I have taken with you three censuses and I feel confident that I can leave my case in your hands."

Dr. Farr's health failed so rapidly after his retirement that he was soon practically lost to the field of scientific labor in which he had been so long engaged, "and which he had graced," says an English journal, "not only with exceptional intellectual power, but with a genial modesty which charmed all with whom he was brought into contact." His scientific friends, who always regretted that the value of his services had not been recognized and better appreciated by the Government, took measures to raise a testimonial fund for him. Subscriptions were obtained to the amount of nearly a thousand pounds sterling, and this sum was invested at his request, and allowed to accumulate for the benefit of his daughters. An effort is now to be made to obtain a grant from the civil list to his daughters, in connection with which it has been remarked that the value of his work has been more unreservedly acknowledged on the Continent and in America than in his own country, where it has not yet received the recognition it is entitled to at the hands of the nation and its Government.

Dr. Farr's admirable personal and social qualities were well known and esteemed by all who had the privilege of meeting him and being associated with him at scientific assemblies. He was modest, kindly, genial, and bright in his manner, and had a generous appreciation of the services of others. "He was deservedly popular," writes one of his biographers, "in the best sense of that word, and, while the friends who mourn his loss on public and private grounds are innumerable, it seems impossible, to those who knew him, to believe in his having a single enemy."

"As a vital statistician," says an English professional writer, in noticing his death, "Dr. Farr's name and work are inseparably bound up with the rise and progress of a science which he had made peculiarly his own. . . . It was the national faith in Dr. Farr, personally, as a vital statistician that invested with so much confidence the registrar-general's statistics, which shed so clear a light upon the black figures of our urban mortality statistics, and thus strengthened the hands of other workers in the field of sanitary reform."

CORRESPONDENCE.

SEWAGE AT THE SEA-SIDE.

Messrs. Editors:

A LETTER in the "Christian Advocate" for March 22d denies the charges made in my article in the "Monthly" for March, as to the unhygienic condition of Ocean Grove during the crowded periods of past seasons. An editorial in the same number of the "Advocate" and another two weeks later call attention to this letter, and challenge "The Popular Science Monthly" "either to prove or retract" these charges. The editor, who says that he is "without personal knowledge" of the conditions of the place, assumes that Ocean Grove has been slandered from anti-religious motives, and avers "that the determining reason which animated the singling out of Ocean Grove for special mention as a sinner above all others in sanitary matters was, . . . because it was, as the writer phrases it, a religious resort."

Now, the writer indignantly disclaims the charge that the question of religion presented itself to her mind. It would, indeed, be a strange association of ideas that could make her attack on bad sewage an assault upon religion. Moreover, it is evident that this editor was not only "without personal knowledge" of the place he champions, but that he was also without personal knowledge of the article which he criticises. Otherwise he presumably would not apply the masculine gender to a writer giving a name purely feminine, nor complain of the "singling out of Ocean Grove," when it was one of six places mentioned, and only twelve lines were given to it. That I was not alone in my criticism is naïvely acknowledged by the editor in characterizing it as "one of various unwarranted attacks," and in his saying that "Ocean Grove has not been excepted from the unfavorable comments" that have been made on various sea-side resorts, and that "the intimations have continued and become rumors detrimental to the character of the place as a health resort."

The letter above referred to is from the Rev. E. H. Stokes, President of the Ocean Grove Camp-Meeting Association. Mr. Stokes says: "*All* our large hotels, and many of our larger cottages, eighty in number, have sewer connections . . . The sewer runs up into the camp-ground occupied by tents, and takes off all the deposits, both of privy and cesspool from there. The grounds on which the tents are located are thoroughly raked over every morning, and the air is pure." From the writer's personal observation extending over a period of three summers, she denies that the sanitation of Ocean Grove was then even tolerably good. Her account, written in August, 1882, on the spot, and sent to the "Monthly" in September, did not overestimate the crowding, nor the effects of the imperfect means which existed for removing fecal accumulations. This was matter of common repute; everybody could smell the vile odors, and many physicians denounced the unsanitary condition of the place. Both the State and the National Boards of Health took notice of these things in their reports for 1882. The former states that in Ocean Grove "the system of water-closet disposal is varied, and depends too much upon the will of each family. The town should ultimately adopt either a public system of weekly dry removal, or connect all closets, both in-doors and out, with a sewer system." It is further advised because Ocean Grove is "so much of a camping-place for the summer, that to the parts thus occupied the strict rules of military sanitary police should be applied and executed by an inspector constantly on duty." "The Sanitarian" for April 5, 1883, published an abstract of a "Report on the Atlantic Coast Resorts," made by E. W. Bowditch, C. E., to the National Board of Health, in which is this statement: "The watering-places on the Atlantic coast of New Jersey are all more or less in a transition state; few have adequate water-supplies, and none are supplied with sewers." Dr. Bowditch thus practically ignored the attempts at sewerage made by the authorities of Atlantic City and Asbury Park, as well as of Ocean Grove.

These authorities, and the statement of the writer's own experience, will perhaps refute the "Advocate" editor's assertion that, "without knowledge of any facts, the reckless charges were penned," and the still more vigorous language of the Rev. Mr. Stokes, who arrogates a thorough knowledge of the five other places criticised, when he writes, "I pronounce the whole article false"! A virtual confession of the truth of the charges is made by the activity displayed during the winter in remedying the causes of complaint. Faults in construction of the Asbury Park sewers have been remedied, and some eighteen thousand feet of sewer-pipe have been laid in Ocean Grove. Fletcher Lake, which last summer was filled with muck, has been cleaned out

and transformed into a respectable body of water. These and other hygienic improvements which have followed in the wake of the fault-finder will doubtless render Ocean Grove and its close neighbor, Asbury Park, satisfactory places for visitors during the season of 1883. That the past winter's work is likely to prove efficient may be gathered from Mr. Stokes's letter, in which he says, "The State Board of Health reports that the sanitary matters of the Grove progress satisfactorily."

It is hoped that the pleasure with which this account is given of a better sanitary prospect for the present summer over that of former years will prove previous charges of improper drainage to have been made only in that spirit which sounds an alarm to prevent danger.

ALICE HYNEMAN RHINE.

COST OF LIFE.

Messrs. Editors:

In an article in the June number of your magazine, entitled "Cost of Life," there are some mathematical calculations, or rather blunders, that make one wonder how they could have been put forth in any journal, though making less claims to science than your valuable magazine. It is gravely stated that a man weighing 150 pounds upon the earth would, upon the planet Jupiter (having 300 times the earth's mass), weigh 45,000 pounds = 22½ tons. The relative mass of Mars is said to be $\frac{1}{60}$ that of the earth, and, therefore, the man spoken of above would weigh only 2½ pounds upon Mars. Now, if the law of attraction as first announced by Newton, and now taught to every schoolboy, is correct, the weight of the above man upon Jupiter would be 2·55 (two and $\frac{55}{100}$) times his weight upon the earth = 382½ pounds—enough to make him decidedly uncomfortable, but still not quite 22½ tons. In regard to Mars there are two errors: first, his mass is $\frac{11}{100}$ that of the earth, not $\frac{1}{60}$ as stated; second, if it were $\frac{1}{60}$, it would not be right to divide 150 by 60, for that would disregard a very essential part of the great law or laws of gravitation. If the radius of Mars is ·52 that of the earth, would not the supposed man weigh, if placed upon his surface, 61 pounds?

There may be some errors in these corrections, but I think they are trifling compared with those in Mr. Pratt's article.

R. S. BOSWORTH.

WATERTOWN, NEW YORK, *May* 21, 1883.

Messrs. Editors:

ALLOW me to call attention to certain assertions in the article headed "Cost of Life" in the June number of your journal. The points I speak of relate to gravity on the planets, and the statements made in regard thereto. It is declared that a man of 150 pounds weight would on Jupiter weigh about 45,000 pounds. It is an elementary truth in physics that gravity decreases as the square of the distance increases; wherefore, although Jupiter is more than 300 times as heavy as the earth, its diameter is more than *eleven* times that of the earth, and the relative weight must be divided by the *square* of the ratio. In this case the divisor is more than 121. The best determinations of the force of gravity on Jupiter give it at a little less than *two and three fourths* that on the earth. So the man of 150 pounds would, on Jupiter, weigh about 400 pounds, not that enormous figure quoted above.

So, gravity on Mars is more than half that on the earth, and our man would weigh 80 pounds, not 2½, as given in the article. Every similar statement in the whole course of the discussion is as badly in error as these here noticed.

It is well known that the destructive effect of a bullet fired by an explosive depends not on the power of gravity, but on that of the powder; and the philosophers who, on Mars, should attempt to catch bullets in their hands, might rue their philosophy. As *science*, the article harmonizes well with the kind in which Jules Verne is accustomed to indulge.

R. W. MCFARLAND.

OHIO STATE UNIVERSITY,
COLUMBUS, *May* 23, 1883.

EDITOR'S TABLE.

THE BACK-DOWN OF DR. DIX.

OUR friend Dr. Dix has deserted us. We have received divers sarcastic congratulations upon our new ecclesiastical alliance, implying that we had made no great acquisition, but we could not anticipate that we should be left in the lurch so soon. We were taken with the impressive declamation about the supremacy of the home sphere in the life of woman, and when Dr. Dix said, "These considerations give the turn to every thought of ours about woman's work"—and of course the preparation

for it, we supposed that this was a living and stable conviction to be consistently carried into practice whenever opportunity arose. But, if we rightly interpret subsequent developments, our confidence was sadly misplaced.

For no sooner had Dr. Dix made proclamation of his views on the woman question, than a rare opportunity was afforded him to reduce them to application in a large and influential way. The Association for the Promotion of the Higher Education of Woman, in New York, had petitioned the authorities of Columbia College to admit women to their institution that they might obtain this "higher education." The petition was referred to a committee, of which Dr. Dix was chairman, and he is declared to be the author of the report that was made upon the subject. It was decided not to admit women to co-education, and it was further declared that Columbia was not able to establish an adjunct institution for the use of female students; but it was offered that, if the women or their friends would provide their own separate accommodations, Columbia College would take charge of the teaching; and, in anticipation of this possible event, the committee prepared such a scheme of studies as it deemed suitable for the purpose in view, viz., to afford woman the facilities for a "higher education" than is now assumed to be available.

Dr. Dix, as we have intimated, drew up this report and framed the curriculum approved by the committee. The situation was thus in every respect most favorable for putting female education upon a higher and more rational basis, and conforming it to the requirements of the feminine character as a preparation for woman's practical life. There were no trammels, the institution was to be newly constituted, and there was no reason for not appealing to first principles in shaping the scheme of studies and embodying all that has been gained in the progress of education. Moreover, there were abundant precedents for shaping the course of studies to the highest ends of practical usefulness. Columbia College has already appended to it a group of colleges devoted to applied knowledge—a mining school, a medical school, a law school, a school of arts, and a school of political science. There was therefore full freedom to construct a new curriculum for female students designed to do whatever a "higher education" can accomplish for the improvement and elevation of woman.

It might have been thought most fortunate that the subject was mainly in the hands of a man who had given special and earnest attention to the question, and avowed fundamental convictions which had a potent and salutary bearing upon the result to be attained. Dr. Dix had said: "The place and work of woman in this world are a place and work in social life; and her place and work are not those of the man." He had said: "Whatever it be in thought, deed, or will that works among us now to break up the home, to make the home idea mean and contemptible in the eyes of woman, or to unfit her for domestic duties, and disgust her with her proper work, whatever now acts on her high-wrought nature, her ambition, her self-love, to turn her steps away from the home-life, and inflate her with visions of a career in the public places outside—this, whatever it be, is working against the best interests, the hope, the happiness of the human race." Could it be imagined that one who had so vivid a conception of womanly nature and destiny, such an appreciation of the higher sphere of her legitimate activities, and so earnest a conviction of the perverting influences to which she is exposed, would frame a working scheme explicitly designed to mold the feminine character in which these guiding ideas are wholly ignored? Yet this is the anom-

alous fact. Drawing up a plan of culture specifically for a sex, nay, for "the sex," the all-controlling element of sex and its vital implications are passed by as if they had no existence. Dr. Dix has prepared a programme of feminine collegiate study in which there is no more recognition of the claims of the home as an object of cultivated thought than there is in the curriculums of colleges exclusively for men. He proposes a course of training which will preoccupy woman for at least a dozen of her most impressible years with a range of acquisitions that have no definite or distinct relation to home interests, and in which the "certificated" young lady can come out as proficiently ignorant of all these matters as the "graduated" young gentleman. His programme, which embraces nine groups of subjects* to occupy four college years, and involves an elaborate preparation for entrance, has not even a corner for physiology, not to speak of other subjects which should be fundamental in any rational system of higher female education.

The satirical writer on education must have had Dr. Dix's plan in view in penning the following well-known passage: "If by some strange chance not a vestige of us descended to the remote future save a pile of our school-books or some college examination-papers, we may imagine how puzzled an antiquary of the period would be in finding in them no indication that the learners were ever likely to be parents. 'This must have been the curriculum for their celibates,' we may fancy him concluding. 'I perceive here an elaborate preparation for many things, especially for reading the books of extinct nations and of co-existing nations (from which, indeed, it seems clear that these people had very little worth reading in their own tongue); but I find no reference whatever to the bringing up of children. They could not have been so absurd as to omit all training for this gravest of responsibilities. Evidently, then, this was the school course of one of their monastic orders.'"

* Dr. Dix's college course for women: 1. The English language and literature. 2. Modern languages and foreign literature. 3. The Latin language and literature. 4. Greek language and literature. 5. History and political science. 6. Moral and intellectual philosophy. 7. Mathematics. 8. Physics, chemistry, and hygiene. 9. Natural history, geology, paleontology, botany and zoölogy.

OPENING DAY OF THE SUSPENDED HIGHWAY.

Although all the world has been abundantly apprised of the fact, yet there is pleasure in still repeating that the opening of the new and splendid bridge over the East River, connecting the cities of Brooklyn and New York, on the 24th of May, was a most successful affair. The grand structure, a monument alike of the marvelous progress of science and art, of constructive genius, and of business enterprise, was recognized by all as a credit to the generation, and the impulse was spontaneous and universal to join in the tributes of honor to the founders and promoters of the enterprise, living and dead, on the occasion of the completion of the work. Business was therefore widely suspended in the two cities; the day of opening became a holiday, and countless thousands of the people gathered to witness the impressive ceremonies, and to express the enthusiastic gratification that filled all minds at the triumphant event. The ceremonies were appropriate and imposing. Parades and salutes, festivities and fire-works, and all the demonstrative accompaniments of high satisfaction, made the day and night memorable among popular celebrations. The oratorical garnishing was, of course, profuse, varied, and excellent, for the theme was well calculated to bring out eloquence of utterance. But the address of Hon. A. S. Hewitt was perhaps the most felicitous

feature of the day. It was simple, pertinent, instructive, and timely, in the considerations suggested by the completed undertaking. It is not often the happy fortune of a man to put the trimmings on a great occasion with such fine propriety as did the oratorical representative of New York in consummating its closer alliance with Brooklyn. We print this speech, and also a brief article on the statistics of the bridge, which, however, can not be authoritative and complete till the issue of the final official report.

THE TYNDALL SCHOLARSHIPS.

Dr. Lucien J. Blake returns to this country at the present vacation from Berlin, where he has been studying physics in the university laboratory of Professor Helmholtz, as a Tyndall Scholar, for the past two years. He has distinguished himself in original work, and will be prepared to take an honorable position as professor in an American college. With the resignation of Dr. Blake there will be two vacant scholarships of the Tyndall Trust Fund, the revenue of which is devoted to the aid of American students of promise who desire to obtain Continental facilities for training in physical investigation. It will be remembered that Professor Tyndall consecrated the total profits of his American lectures ten years ago to this noble object. The proceeds of those lectures, beyond the payment of necessary expenses, he refused to regard as belonging to himself, but left them as a fund in the hands of trustees to be used for the benefit of American young men of capacity and ambition, to prepare themselves for a life of original experimental work in physical science. The provision was wise as it was generous, for while, on one hand, the students of pure science are without the strong incitements of pecuniary reward for their labors, on the other hand, the encouragements to scientific study are too often in the direction of its immediate utilities. Aware of the strong temptation in these times to cultivate science from the lower motives, Professor Tyndall has lent the influence of his example, his teachings, and his substantial earnings to stimulate and sustain those youthful devotees of scientific truth who would pursue the work of research from the simple and elevated motive of a desire for the extension of valuable knowledge. Those wishing to obtain the benefits of the Tyndall Fund should apply to its trustees, Professor Joseph Lovering, of Harvard College, Cambridge, Massachusetts; President F. A. P. Barnard, of Columbia College, New York; and the senior editor of this periodical.

PROGRESS AND THE HOME.

Dr. Emily Blackwell discusses the industrial position of woman in a way that appears to us especially significant at the present time. We said not long ago, "If there is one thing that pervades and characterizes what is called the 'woman's movement' it is the spirit of revolt against the home, and the determination to escape from it into the outer spheres of activity that will bring her into direct and open competition with men." This statement has been criticised as unjust; but we certainly did not mean to intimate that there may not be many women thoroughly enlisted in the "woman's movement," and who, nevertheless, retain a strong home interest. Our statement was general, and simply affirmed a widespread tendency, the unmistakable drift of which, we think, the article on "The Industrial Position of Woman" decisively illustrates.

It will be seen that Dr. Blackwell writes as a student of social tendencies. She appeals to the primitive condition of society, falls back upon the law of progress, and forecasts the results of its

future working upon domestic life. The industrial progress of mankind, as is well known, has been carried forward by the division of labor, in which, through greater proficiency of specialized work, improved machinery, and efficient organization, the productive capacities of society have been much diversified and augmented. Dr. Blackwell's argument is that this great social tendency has taken effect upon the domestic sphere, and must take much further effect by removing those forms of domestic labor with which women have been so long burdened, to the outside sphere of business organization. She maintains that woman must follow out these industries into the outer field of competition, or be left without the means of subsistence; while, by thus getting rid of all work hitherto called domestic, she will achieve her liberation from that home bondage of which she has so long been the victim. The social movement here referred to has two effects—the enlargement of external competition for woman, and a corresponding diminution of the internal sphere of home occupation. We must very briefly object to Dr. Blackwell's views upon both points.

As to the industrial tendencies of social evolution invoked by Dr. Blackwell, she seems to have left out the most important, and, indeed, in this case, an all-determining consideration. While the common differentiations of industry are a result of progress, that between the sexes is not a result of progress. The division of labor between the sexes is primordial—older and deeper than all social development, and a fundamental condition to it. Any one who will consult the comprehensive "Cyclopædia of Descriptive Sociology," by Herbert Spencer, and refer to the operative division of his tabular summaries, will find superabundant proofs that in the very lowest stages of all savage societies there was a fundamental and universal separation in the active spheres of the sexes, so that "no division of labor except that between the sexes" becomes almost a stereotyped formula. Men devoted themselves to hunting, fishing, and war, for the maintenance of the life of the tribe, while women cooked the food, made the clothes, took care of the children, and occupied themselves chiefly with the drudgeries of the rude home. Thus, before industries began to take any separate shape, there was already a division of occupations so broad and clear as to be evidently grounded in the nature of things, and all the subsequent progress of mankind has been achieved in subordination to it. The first great specialization of human activities is, therefore, not a product of social evolution. We have here to do with a fact of exceptional import, deeply grounded in the constitution of things, and not to be studied as an effect of social progress. And in its essential quality, moreover, this separation of the spheres of action of men and women is totally different from the ordinary differentiations of industry. The historic relation of the sexes, in regard to their distinctive spheres of action, is a non-competitive relation. The family arose not merely by a union of the sexes in marriage, but by a union of interests which made their respective spheres of occupation supplementary to each other. There is here no industrial rivalry, but the common ambition centers in the prosperity of the home. This is the fixed order observed equally in all stages of progress. As men fished, hunted, and fought in the pre-industrial stages of society, while women were occupied with the domestic cares, so the men still labor without, struggling with their fellows in the arena of business, and earning wealth which it is their pleasure and pride to expend upon the home and for the advantage of the family, while wives and mothers co-operate in the household sphere, contributing their indispensable and co-equal share

to the common domestic welfare. But the relation of woman throughout has not only been non-competitive, but the fundamental fact in the case is that it has been a relation of protection. Not more in the predatory life of the savage than in the highest civilized life, woman has been the protected sex. Her security, and through it the maintenance of the social order, and the progress that has resulted, have not arisen from the independent competitive struggles of woman, but from the identification of her interests with those of man, through the division of their spheres of action. We await the reasons which are to convince us that these deeply-grounded relations must not continue throughout the future of humanity. The precipitation of woman into the outer world of conflicts, where the strongest have their way, would involve a dissolution of human society, and is not even possible as an experiment. Granting that the protection of woman has always been, and is still, very imperfect, progress must consist in making it more perfect, and not in subverting the order of which it is a natural and necessary part.

And now let us note the correlative effect upon the home of Dr. Blackwell's thorough-going social reform, and point out its radical error. She says: "There is no reason why what is now done by domestic service should always continue to be so done. As weaving and tailoring have gone, so the making of women's and children's clothing is now going. There is no reason inherent in the nature of things why washing, cooking, mending, etc., should not go also, and be done by business organizations from outside, instead of by domestic service. Thus domestic work will be reduced to the minimum, to that part most intimately connected with the personal life of the family. The need of domestic service will diminish in the same proportion, and the problem it presents will be solved by its diminution or gradual disappearance." But this process of the "gradual disappearance" of domestic activities and their relegation to outside organization is to be carried still further, so as to remove from the home the nurture of even "very young children." "There is nothing which would seem more absolutely dependent upon the mother than the care and training of very young children. Yet the careful study of the best modes of training these early years, which has come in with the Kindergarten, shows how far the nursery alone is from meeting their needs; how early and how much skilled teachers, other children, a variety of apparatus—that is, outside help—are desirable for the best interests of the child, as well as for the assistance of the mother."

It is not surprising that Dr. Blackwell should anticipate the very natural objection "that so radical a change in the conditions of household work must imply the destruction of the home as we at present understand it." She intimates that the dread is illusive, but she by no means replies to the objection. And that the logic of her position leads inevitably to this result is undeniable. For, when the process of removing all that can be removed from the domestic sphere, and handing it over to outside organization, is completed, not a remnant of family life "as we at present understand it" can remain. As spinning and weaving, brewing and drying fruits, tailoring and knitting, butter and cheese making, have gone, so washing, mending, sewing, and cooking can go also in the same way, and the sick can be sent out to the hospitals. And when the Kindergarten becomes a state institution, and "compulsory education" takes away the "very young children" to be cared for by outside arrangements, and all kinds of domestic occupation are thus eliminated, it might appear that the home has been reduced to its minimum as a place for the bare organic

processes of gestation and lactation. But will progress, under such heroic interpretation, leave even this shred of a domestic sphere? Is not the stirpiculturist abroad with his lamentations over the evils of the unregulated multiplication of human beings, and is he not predicting the time when human perfection shall be attained through the total disappearance of present domestic relations, and their better discharge under the control of outside organization? Dr. Blackwell declares that the personal relations in the family are "a fixed and constant element"; what is her warrant for the declaration in the light of the slow-working progress she invokes.

Dr. Blackwell's argument rigidly carried out would sweep the family and the home out of existence, and merge it in the outside life of society, where all regulation falls within the province of the state. Her reasoning goes to the most chimerical lengths through a failure to recognize that there is a permanent sphere of legitimate distinctive womanly work. Her affirmations that "there is no one kind of work which absolutely belongs to domestic life," and that "there is no necessary connection between domestic life and domestic work" can not for a moment be accepted as true. They are no more true than would be the proposition that there is no necessary connection between life and work at all. There are plenty of people who live and never work, but it remains true that human life is inexorably conditioned upon work. There are women who never do domestic work, who abandon the home, and live in hotels; but it is still true that domestic work is a condition and necessity of home-life—so true that, if domestic work disappears, the home is impossible. If there is a house, there must be housekeeping; if there are children, they must be cared for; if there are invalids, they must be nursed; if there is food, it must be prepared, and all these things involve work as a simple practical necessity. Because there has been a great deal of foreign and unfeminine work carried on in the household is no reason for asserting that there is no such thing as proper feminine domestic work. The home has, of course, been burdened by these industries, and women made drudges to them, and we all bid Godspeed to their exodus. But for what reason? That woman may be released from exhausting, unfeminine occupations, to give more strength to the proper performance of her legitimate duties as wife, mother, and household administrator. Weaving, cheese-making, and domestic manufactures stand in no relation to the essential nature and characteristic duties of woman. Such occupations have robbed her of leisure for self-improvement, and want of suitable culture has hitherto prevented the mass of women from properly performing the duties which lie in the very heart of home. Every step of progress from the primitive state to the present has been in the direction of woman's emancipation from the hardships of physical labor, and coincident with this relief there has been an improvement in her nature, the gentler virtues appear and the finer qualities of the feminine mind are developed. But the ideal of womanhood toward which such considerable progress has been made is not the fine lady, idle of hand and brain, the gadding and gossiping woman of leisure and society, who evades or discharges with wretched incompetence the cares and responsibilities of domestic life. Womanly talent and cultivation are demanded in the line of strictly feminine occupations, that the home shall become more and more instead of less and less in the social life of the future.

We have no space here even to enumerate the varied forms of womanly activity involved in the home, when all its extrinsic burdens are removed. That which progress must bring us is not exemption from them, but their more

intelligent and congenial performance. The adequate education of woman for the home sphere we have never had, and it is now resisted with all the power of traditional habit and all the influence of the old educational ideals and the organized systems of study. Men are educated by the newer colleges for their special work in life; women never! The prejudice against studying things domestic, although the problems opened are many and of the deepest intellectual interest, abides with a strange inveteracy. Dr. Blackwell recognizes no amelioration of the home through intelligent preparation for it. Though education is now the standard solvent of all the difficulties in our civilization, she concedes to it no potency in renovating and developing home-life. She asserts, indeed, that women must have technical training for the sphere of outside competition, but nothing is said of its need as a preparation for domestic activities. As long as the home endures, it is to continue the stronghold of servility and degradation. Progress is to do wonders, but the home must remain the asphyxiating Black-Hole of menial ignorance and stupidity as lasting as may be the vestige of the institution. There are perhaps not many who will go to this visionary extreme, but in so far as the "woman's movement" exemplifies the feeling it merits unsparing condemnation.

LITERARY NOTICES.

CONFLICT IN NATURE AND LIFE: A STUDY OF ANTAGONISM IN THE CONSTITUTION OF THINGS. For the Elucidation of the Problem of Good and Evil, and the Reconciliation of Optimism and Pessimism. New York: D. Appleton & Co. Pp. 488. Price, $2.

THIS anonymous work is in the most comprehensive sense an ethical essay upon human life in connection with the order of nature. It is a philosophical inquiry into the constitution of natural things, as it bears on the fundamental problems of good and evil, which, as the writer thinks, have been prematurely resolved in the theological stages of thought, before science had furnished the conditioning data for dealing with the morality of nature and the ethical possibilities of mankind. With legendary ideals of golden ages and paradisiacal states, at the opening of man's career, and the hopes and prophecies of millennial felicity to be finally attained, and with numerous intervening revelations, evolutions, and reforms, as means of regaining the lost paradise and reaching a condition of ultimate perfection and supreme happiness—as exemplified by all this, the author thinks that we have been dominated by a chaotic and groundless philosophy, only to be escaped through a better understanding of the existing order of things, and the way it must operate until replaced with quite another order. Is the optimist justified in blessing the world? is the pessimist justified in cursing it? or is it a mixed affair, that must be systematically comprehended before it can be morally estimated?

It appears that, long ago, while the author was hoping for harmony and happiness on the basis of an optimistic constitution of nature, he began to perceive that, at every point gained in the direction of freedom and intelligence to secure greater harmony and perfection in life, some new element of discord and danger would arise to vitiate the result—such element being not incidental but necessary, and bound up with the scheme of things. Thus, in order to avoid the evils of ignorance, we must promote education, which increases the sensibilities for keener enjoyment, but which at the same time whets them equally for intenser suffering. Civilized people enjoy more than savages, but they also suffer more; and, while the higher classes enjoy more exquisitely than the lower, they have their own characteristic troubles to deal with. Further, personal sovereignty has a good side, but also an evil side; and there is no such thing as absolute or perfect freedom. Freedom is self-limiting, and hedged about by barriers which are necessarily impassable, except at the expense of freedom itself. Again, political centralization has advantages which no great people can afford to dispense with, but it must be carefully guarded or it will result in despot-

ism. So, also, local self-government has peculiar benefits which no free and intelligent people should ever forego; but local autonomy involves political weakness, which is not to be neglected. And so in attempting to get away from the evils of indissoluble marriage by opening a way of escape, we find ourselves at once in the presence of new evils, and the proper balance of stringency and liberality is by no means clearly seen and ready of attainment.

It was this conception of life, as involving in all its aspects a choice of evils, that led the author on to the study of the *necessary antagonisms* in the constitution of nature, and which he found to be equally displayed in the lower orders of life, and to be rooted in the actions and reactions of the physical forces themselves. His book is an attempt to trace out this principle of conflict in the order of natural things, from its simplest to its most complicated manifestations.

Part I is intended to show the past prevalence of optimism and the fragmentary and fruitless conceptions of antagonism exemplified in the views of eminent representative men by summaries and brief quotations from their writings. Part II deals with the fundamental conceptions of existence, and speculations concerning the primary forces into which the conception of conflict has entered as an undefined principle of the philosophy of science. Its illustrations are traced through a series of the principal branches of science, physics, chemistry, biology, mind, morals, etc. The last chapter deals with morality in accordance with the ethical systems that have grown out of utilitarian experience, on the hypothesis that the moral instincts become fixed by association and habit, and in which the higher faculties or the later organized or more complex feelings overrule the lower or earlier developed feelings in determining ethical action. This chapter insists on the struggle in life through which morality has taken form as conduct in the direction of least social conflict. The author maintains that the prevalence of moral order has been determined and is maintained through conflict as really and to quite as great a degree as the struggle for existence has produced the local forms among plants and animals. The writer observes that Mr. Spencer recognizes antagonism in the origin and development of moral systems, but also indulges in optimistic anticipations which are without warrant in "the constitution of things." He interprets Spencer as maintaining that industrialism is to supersede militancy in such a manner that antagonism will be done away with. But the author insists that any possible industrialism only complicates antagonism and changes its forms. Part III illustrates the subject from a survey of history, and Part IV deals with it in connection with the theory of evolution. The doctrine is, of course, accepted, and the exposition of it given in Spencer's "First Principles" is taken as authoritative; but the writer is of opinion that the principle of antagonism is not accorded its due weight, and various exceptions are taken to the Spencerian argument. Part V is chiefly devoted to the discussion from the point of view of geology and meteorology, showing that the necessary conditions of physical life and enjoyment necessarily involve discord and pain. Part VI illustrates the subject in relation to practical life, and aims to show that, whatever schemes of improvement may be adopted, there are always drawbacks, accompanying evils, which stand in the way of perfection in results. The chapter on "Relative Prolificacy" deals with this agency not only as a permanent and perpetual social element, but in its immediate bearing upon the various grades and classes of society, and it involves a criticism of the tendency to overrate the optimistic side of evolution.

It will appear, from what we have said, that this work on conflict is offered as a contribution to the philosophy of life, or as deepening the foundations for such a philosophy. The claims in this direction are brought out in a general way in the final chapter. Its conclusions are broadly practical. The philosophy of conflict inculcates moderate expectations. Avoiding the extremes of optimism and pessimism, of conservatism and radicalism, it aims to do work only where work will be effectual—work that will make things better, and work which prevents them from becoming worse.

We have here endeavored simply to state the general object of the book before

us, and briefly to outline the course of its argument; but our sketch gives no adequate idea of the number and importance of the specific topics that are treated in the course of the exposition. Many of the larger and more urgent questions of the time are taken up, and, while considered in relation to the fundamental principle which it is the object of the work to develop, they are handled in a way that is full of suggestiveness and valuable instruction.

OUR HOME PHYSICIAN: A POPULAR GUIDE TO THE ART OF PRESERVING HEALTH AND TREATING DISEASE. By GEORGE M. BEARD, M. D., assisted by Eminent Medical Authorities. New York: E. B. Treat. Pp. 1,506, with Plates. Price, $6.

THIS work is designed to present, in a form intelligible to ordinary readers, a review of the whole field of medical science, so far as it is of practical application and popular acquaintance with it is desirable. It includes within its scope anatomy, physiology, hygiene, and the employment of simple treatment and remedies. It gives information concerning the structure of the human body and the functions of its organs; on diet, stimulants, narcotics, air, sunlight, exercise, and bathing; on the care of the sick-room, the management of infants and children; on the general laws and history of disease; and on the treatment of accidents and emergencies, with descriptions of familiar remedies, for all persons and every household; together with suggestions concerning the special care and treatment of obscure and grave diseases and the application of powerful remedies, for persons who, like planters, miners, sailors, travelers, and dwellers in remote districts, are beyond the reach of skillful medical aid, and must be either treated by themselves or by their friends, or left to suffer. The great advance that has been made in the science of medicine during the last quarter of a century is duly recognized; and prominence is given to the view that the types, phases, and names of diseases have wonderfully changed during that period, and that a greater revolution has been wrought in the method of treatment and the selection of remedies. Hence, physicians are more successful in the treatment of disease now than formerally; and the fact is enforced that a large number of maladies formerly regarded as incurable have been found susceptible of relief and cure, and that the accession of a considerable proportion of diseases may be prevented by timely and suitable precautions. On the subject of medical schools and systems, the broad principle is assumed that "the wise physician of our time uses for his patients all things that have been proved to be beneficial." The author has been aided by authorities and physicians of recognized standing in the preparation of the several departments of his work. His aim has been, in his own words, "to prepare a comprehensive, popular treatise, . . . that shall say just enough to instruct and not so much as to bewilder; that shall fairly represent the various departments in language both clear and attractive, as well as accurate and instructive; that shall make broad and plain the boundaries between those subjects which the people can and should know and those which they should not attempt to know; and that shall treat all this large variety of themes in such a manner as not to offend the taste of the best-ordered household." The work is illustrated by fifteen chromolithographic plates and numerous woodcuts.

THE CORRESPONDENCE OF THOMAS CARLYLE AND RALPH WALDO EMERSON, 1834–'72. Boston: James R. Osgood & Co. Vol. I, pp. 368; Vol. II, pp. 383. Price, $4.

THIS work, edited by Charles Elliot Norton, is one of remarkable interest, and is unique in literature. It covers a period of thirty-eight years in the intellectual life of two gifted and remarkable men belonging to different nationalities, and who were early drawn together by a sympathy of ideas and a mutual appreciation of genius before either had conquered a position in the world of public letters. The work has all the interest of personality, and is a sort of compound autobiography or revelation of the inside life of the distinguished men whose intimate and prolonged correspondence makes up the volumes. The characters of Carlyle and Emerson were, of course, both formed before they came into this relation of close correspondence; but the epistolary record covers the period of their mental development, and brings it to the maturity of advanced age, when it ceased, through the decline of liter-

ary enthusiasm, and perhaps through a divergency of views which became settled in the later period of life. Both men went through important transitional stages in their mental experience, Emerson escaping from the transcendentalism of which he was the early apostle, and is said to have been the inventor, in New England; and Carlyle escaping from the intense radicalism of his opening career into the pessimistic conservatism of his maturer years. The work, therefore, has abundant interest as a study of character through the free disclosures of a copious and varied private correspondence. In the first place they were both men of unrivaled powers of expression, and the highest capacity of analyzing their own mental conditions, and presenting them with vividness and original force. It is, perhaps, not to be supposed that they were unconscious that what they said would ultimately be given to the world; but this consideration operated as but a partial restraint upon the freedom of their communications. They were both men of opinions—thinkers, *doctrinaires*, students of men and society—and therefore had much to say pertaining to contemporary events, especially in the field of current speculation, and in relation to the literary phenomena of their period. They spoke with a liberty about contemporary men in the world of authorship which gives a pungent interest to the letters, and which was sometimes carried so far that the editor is constrained to disguise the names of parties implicated. But the strictures made were generally within such proper limits that no such editorial intervention was necessary. The two men are here pictured by themselves in their full individualities. These, of course, are shown in their respective writings, and it can hardly be said that there are any new disclosures in the correspondence that can much revise or affect the judgment of those who are already familiar with their books; but the result of a perusal of their letters is like turning on the gas which brings everything out into greater distinctness. It is unnecessary, of course, to commend these volumes to the attention of readers. All those who are familiar with the thought and the history of these men as authors, displayed in their successive publications, are certain to procure and peruse this correspondence. But Carlyle and Emerson now belong to the past, and the new generation of readers can be but partially familiar with those stages of mental development through which they passed many years since, and which were eagerly observed by their contemporaries as they went forward with the issue of their books. For those younger readers, therefore, to whom these authors are historic, the volumes before us may be recommended as full of special instructiveness in interpreting the character and position of these men whose eminent position will be permanent in the literature of the future.

The Examination of Medicinal Chemicals: A Guide for the Determination of their Identity and Quality. Illustrated; third edition, revised and enlarged. By Frederick Hoffmann, A. M., Ph. D., Public Analyst to the State of New York, etc., and Frederick B. Power, Ph. D., Professor of Analytical Chemistry in the Philadelphia College of Pharmacy. Philadelphia: Henry C. Lea's Son & Co. Pp. 624. Price, $4.25.

The present edition of this valuable work contains a large amount of new matter, and has been adapted to the recent editions of the United States and German Pharmacopœias. Part I describes the operations and reagents necessary for analytical work, gives a system of qualitative analysis, directions for volumetric analysis, and for detecting the most important alkaloids. Part II describes the various substances that are used medicinally, giving their physical and chemical properties, the impurities that are to be looked for in each, and the way to detect them, and, whenever desirable, a method of assay. Under their appropriate heads are given directions for testing for the important poisons in forensic investigations, processes for the determination of glycerine in wine and beer, of the alkaloids in cinchona-barks, etc., and rules for the dilution of the important acids, etc., together with tables of the strength of solutions.

The authors have aimed to make each article complete in itself, preferring to repeat text and illustrations rather than send the reader to several cross-references. The volume is well supplied with illustrations of apparatus and forms of crystals, and contains unusually detailed tables of equivalent

weights, measures, and temperature, in the decimal and the old system. It has been brought up to the latest established results in its department, and can not fail to be a valuable possession to every one whose business it is to prepare, prescribe, or dispense medicines.

THE POSSIBILITY OF NOT DYING: A SPECULATION. By HYLAND C. KIRK. New York: G. P. Putnam's Sons. Pp. 112. Price, 75 cents.

THE author of this speculation says: "The proposition 'all men are mortal' is an unsound assumption—unsound because not based on actual knowledge. Men subjected to certain conditions are mortal. This is a true proposition. That men subjected to certain other conditions may be immortal, we can not deny. As knowledge is, our subject involves merely a matter of uncertainty, unless data can be procured such as shall afford means of determining the truth."

The author then goes back, as usual, to Columbus and Galileo, to show that both in the realms of discovery and invention suppositions generally regarded as absurd have proved to be correct. And as the doctrine of the sphericity of the earth was once held to be absurd, but is now proved to be true, he maintains that the theory of physical immortality, though now regarded as absurd, may yet be found true.

Moreover, it is a great time now for progress of all sorts, and after the telegraph and phonograph and telephone, who shall assume to say what may come next? The secret of earthly immortality has been dreamed about a great deal, and patentable arts of prolonging life indefinitely are no novelty. Paracelsus announced that he had found the elixir of life by which men might be enabled to live forever, but, as he died himself in middle age, the announcement seems to have been premature, the invention, like that of perpetual motion, having been probably not quite perfected. Mr. Kirk offers no contrivance by which death may be escaped, but he is full of ingenious reasonings to show the theoretic possibility that, by a system of right living, earthly life could be made to last forever.

Mr. Kirk argues that the end he proposes is desirable, which is far from certain. The question is very seriously mooted nowadays whether, even in its brevity, "life is worth living" at all; but it is pretty clear, at any rate, that it is only tolerable through its brevity. The experiment of trying life for a time is certainly interesting; but the most beneficent part of the arrangement is, that its eternal continuance can be escaped, at least in this state of being. Mr. Kirk considers the matter from the point of view of evolution, which, as it raises humanity to a plane of higher possibilities, may find everlasting life among them. But evolution seems to be made possible only through death—by constantly getting rid of the less perfect to make room for the more perfect. Shortening life multiplies lives, so that while the vital stream is continuous, in an immortal progress, individuals are replaced in the succession by better ones, and, if there be the slightest advantage in living, it is increased by the indefinite multiplication of separate lives. If any one set could find a way of holding on, would there not be an end of evolution? We are much inclined to think that it would be hard to conceive anything more calamitous than to have Mr. Kirk's reform practically carried out. Even now the "Old Hunker" element in human affairs defies everything but death, but what kind of a world would this be if the Civil-Service Commission could confer upon office-holders an immortal tenure?

BULLETIN OF THE UNITED STATES FISH COMMISSION. Vol. I, for 1881. Washington: Government Printing-Office. Pp. 466, with Twenty-one Plates.

To secure a more speedy dissemination of the information collected by the Fish Commission, it has been authorized to publish an annual "Bulletin," of the edition of which a part is to be distributed signature by signature (in the sheets as they are printed), and the rest in bound volumes. The present is the first of the series of volumes. It contains a large number of papers of varied importance on the different aspects of fish-culture and fishing, with a table of contents arranged alphabetically by authors, and an admirable index. Among the papers of more general interest are those on "Recent Contributions to Pond Cultivation," "Treatment of Fish-Eggs at Sea," "The Dry Transmission of Fish-Eggs," "The Destruction of

Young Fish by Unsuitable Fishing Implements," "The Winter Haddock-Fishery of New England," "The Influence on the Coast Fisheries of the Steamers used in the Menhaden Fishery," "Artificial Culture of Medicinal Leeches and of Species of Helix," and "Changes in the Fisheries of the Great Lakes during the Decade 1870–1880."

ELECTRO-MAGNETS: THE DETERMINATION OF THE ELEMENTS OF THEIR CONSTRUCTION. By TH. DU MONCEL. New York: D. Van Nostrand. Pp. 122. Price, 50 cents.

THE author's purpose is to give a plain, practical essay on the subject, adapted to the use of amateurs, experimenters, and working artisans, as well as of students. Though the laws on which the formulas are based have not been fully verified, yet results have been obtained so nearly approaching verification as to make it safe to admit them as guides in the construction of electro-magnets.

A PERPETUAL CALENDAR. By President F. A. P. BARNARD. Price, 40 cents.

THE calendar, though having a rather complicated appearance at first sight, becomes simple and easy of operation when its theory is once explained. It consists of a sheet of stiff pasteboard, to the top of which is attached a revolving disk bearing the names of the months and the numbers from 1 to 99, while the main sheet contains seven parallel columns of the days of the month. The disk should be properly set to the columns at the beginning of each year; then the day of the month can be found on looking for it.

POCKET LOGARITHMS, TO FOUR PLACES OF DECIMALS. New York: D. Van Nostrand. Pp. 139. Price, 50 cents.

SURVEYORS and other persons engaged in field-work often find themselves in need of tables of logarithms in a form which they can conveniently carry with them. The present volume is for the use of such persons. Its four-place tables give as close an accuracy as is likely to be required in field-work. They include the logarithms of numbers, and logarithmic sines and tangents to single minutes, with a table of natural sines, tangents, and co-tangents.

FIRST ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY TO THE SECRETARY OF THE SMITHSONIAN INSTITUTION, 1879–'80. By J. W. POWELL, Director. Illustrated. Washington: Government Printing-Office. Pp. 603.

THE act of Congress of March 3, 1879, which established the United States Geological Survey, made provision for continuing, under the direction of the Smithsonian Institution, the anthropologic work that had been carried on by the earlier surveys. The methods of the new bureau have been, "first, the prosecution of research by the direct employment of scholars and specialists; and, second, by inciting and guiding research immediately conducted by collaborators at work throughout the country." The latter division of the work has been furthered by distributing manuals upon various branches of the study, designed to make the investigations of independent workers systematic and thorough. Being convinced that the social institutions of the Indians can not be understood without a knowledge of the means adapted to express accurately the ideas embodied in those institutions, Major Powell has directed a large share of attention to language, and about two thirds of the present volume is occupied by papers on that subject. The longest of these is one by Lieutenant-Colonel Garrick Mallery on "Sign Language among North American Indians compared with that among other Peoples and Deaf-Mutes." This is drawn up merely as a report of progress, and consists of a part of the data on this subject that have been obtained by the bureau. A large number of Indian signs are herein graphically described and fully illustrated, though perhaps more space is given to describing the signs of other peoples than is absolutely necessary for purposes of comparison. A paper by the director describes quite a complete system of government that exists among the Wyandots; and another, also by Major Powell, is an interesting and thoughtful sketch of "Indian Mythology." The contribution of greatest popular interest is a second paper by Dr. H. C. Yarrow on mortuary customs, which embodies many communications from recent investigators, together with a large number of extracts from writers who have touched upon this subject within the last two hundred years.

While earth-burial, either with or without embalmment or partial cremation, seems to have been the general custom among North American Indians, other methods of disposing of bodies are also known: as aërial sepulture, or leaving the body in a box or canoe, which is supported on a scaffold or tree; and aquatic burial, which consists in sinking the body in a stream, or setting it afloat in a canoe. Violent expressions of grief are expected from the friends of the dead, and especially from widows. Some of these are, blackening the face, shaving the head, and cutting the flesh—all being accompanied by mournful cries, and sometimes hired mourners being employed. In some tribes, the widow observes a long period of mourning, involving many discomforts, and in others she submits to being put to death at the grave. This volume does not include all the material collected before its date, nor does it mark the end of the bureau's labors; all investigators of American ethnology are earnestly requested to co-operate in the further work of the bureau, and cordial thanks are offered to those who have already contributed their observations.

AMERICAN HUMORISTS. By the Rev. H. R. HAWEIS, M. A. New York: Funk & Wagnalls. Pp. 180. Price, 75 cents.

THIS is a reprint of a course of lectures which were delivered at the Royal Institution in London, on six of those whom the English regard as our most characteristic and typical humorous writers, viz., Washington Irving, Dr. Holmes, Mr. Lowell, Artemus Ward, Mark Twain, and Bret Harte. The pervading quality of the wit of each of these authors is analyzed, and is illustrated by liberal citations from the most characteristic of their writings. The work is not satisfactory to all the critics, but this arises probably as much from the fact that the flavor of humor can not be conveyed, as from any deficiencies of the author.

JESUS, HIS OPINIONS AND CHARACTER: THE NEW TESTAMENT STUDIES OF A LAYMAN. Boston: George H. Ellis. Pp. 471. Price, $1.50.

TAKING a judicial and critical rather than a partisan attitude, the author has collected and arranged systematically what Jesus seems to have thought about the various subjects upon which his followers represent him as teaching. The author's data are taken from the first three gospels, while the fourth is regarded as a genuine early commentary, and as such is referred to by way of illustration. "Every great historical personage," our anonymous author writes, "to be understood, must be studied in connection with his dominant idea." This dominant idea in the case of Jesus he finds to be the "doctrine of the kingdom of heaven," and insists that this doctrine be kept clearly in view, as the central idea "around which was grouped all that he said and taught." Successive chapters take up the political, ethical, philosophical, and religious ideas of Jesus, his ideas of a future life, the miracles attributed to him, his arrest, trial, and death, his personal pretensions and character, and the legend of the resurrection, the last chapter being devoted to the "Influence on Historic Christianity of Paul and John."

AN INTRODUCTION TO THE STUDY OF ORGANIC CHEMISTRY. By ADOLPH PINNER, Ph. D. Translated and revised from the sixth German edition, by PETER T. AUSTEN, Ph. D., F. C. S., Professor of Chemistry in Rutgers College and the New Jersey State Scientific School. New York: John Wiley & Sons. Pp. 382. Price, $2.55.

ENGLISH-SPEAKING students of organic chemistry have suffered from a dearth of suitable elementary text-books in their own language; hence this translation of Pinner's standard work is to be heartily welcomed. The book is too well appreciated in the original to need comment here; the translation follows the easy lecture-style of the original, and contains additional matter describing the most important recent discoveries.

ENTOMOLOGICAL PAPERS FROM THE TRANSACTIONS OF THE IOWA STATE HORTICULTURAL SOCIETY, FOR THE YEAR 1882. Des Moines, Iowa: F. M. Mills, State Printer. Pp. 42.

THE papers include one on the injury done by insects in orchards, by the Hon. J. N. Dixon; notes on the "Injurious Insects of 1882," by Miss Alice B. Walton; and "Entomological Notes," for the year, by Professor Herbert Osborn, all of which have a practical bearing.

MANUAL OF ASSAYING GOLD, SILVER, COPPER, AND LEAD ORES. By WALTER LEE BROWN, B. Sc. Chicago: Jansen, McClurg & Co. Pp. 318. With Illustrations. Price, $1.75.

THE author of this manual has aimed to produce a guide for those who, having had no previous training in chemical work, wish to learn assaying. Hence, he gives first full descriptions of the apparatus required, generally with illustrations, names of makers, and prices. The reagents are as fully described, and, wherever necessary, methods of preparing and testing them are given. The processes of assaying are detailed with great clearness, from the crushing of the ore to the estimation of its value per ton, and in the appendix are given various special methods of assay, lists of minerals likely to contain gold, silver, copper, or lead, a list of books on assaying, various departments of chemistry, mineralogy, mining law, etc., and useful tables. The volume is got up in much better style than is usual with scientific and technical manuals.

REPORTS OF EXPERIMENTS, CHIEFLY WITH KEROSENE, UPON THE INSECTS INJURIOUSLY AFFECTING THE ORANGE-TREE AND THE COTTON-PLANT. Made under the Direction of the United States Entomologist. Washington: Government Printing-Office. Pp. 62.

THE expediency of using kerosene has been disputed, chiefly on account of the danger of its injuring the plants. The objection is applicable to pure kerosene, and with greater force as regards some species than others. Professor Riley advises that kerosene be used with caution where its effects are not already known, and never be employed pure. With this reservation, his own experience and that of his assistants shows that neither lye nor whale-oil soap, the other substances recommended, "bears comparison with an effectual kerosene emulsion as an effectual destroyer of scale-insects and their eggs."

SHADE-TREES, INDIGENOUS SHRUBS, AND VINES. By J. T. STEWART, M. D. Second edition, revised and improved. Peoria, Ill.: Transcript Publishing Company. Pp. 37.

THIS paper was prepared with particular reference to the city of Peoria, and was read by request, in December last, before the Scientific Association of that place. It is the fruit of many years of observation and much careful study, and consists chiefly of notes on native species and their adaptability to the soil, climate, and situation of Peoria, with directions for their cultivation and care. Much of it is applicable to other places than Peoria.

PROFESSIONAL PAPERS OF THE CORPS OF ENGINEERS, UNITED STATES ARMY. No. 24. Report upon the Primary Triangulation of the United States Lake Survey. With 30 Plates. By Lieutenant-Colonel C. B. Comstock. Washington: Government Printing-Office. Pp. 922.

THIS is the final report of the survey, begun in 1841, of the Northern and Northwestern lakes. The work is described under the headings, "Standards of Length, Bases, and Base Apparatus," "Primary Triangulation," "Astronomical Determinations," and "Principal Results of the Geodetic Work." A short history of the survey is prefixed to the volume.

ASTRONOMICAL PAPERS, prepared for the Use of the American Ephemeris and Nautical Almanac, under the Direction of SIMON NEWCOMB, Ph. D., LL. D. Vol. I. Washington: Bureau of Navigation, Navy Department. Pp. 487.

IN this volume is begun the publication of a series of papers whose objects are "a systematic determination of the constants of astronomy from the best existing data, a reinvestigation of the theories of the celestial motions, and the preparation of tables, formulæ, and precepts for the construction of ephemerides, and for other applications of the results." The present volume contains papers on the "Recurrence of Solar Eclipses," "Hansen's Lunar Theory," "A Determination of the Velocity of Light," "A Catalogue of 1,098 Standard Clock and Zodiacal Stars," on "Gauss's Method of computing Secular Perturbations," and a "Discussion of Transits of Mercury from 1677 to 1881."

THE BACTERIA. By T. J. BURRILL, Ph. D. Springfield, Ill.: H. W. Rorker, State Printer. Pp. 65, with Illustrations.

EVERYBODY wants to know all about the bacteria which have been found to play so

important a part in the operations, whether useful or destructive, of life; but books in which satisfactory accounts of them are given are as yet rare, and hardly accessible. The author of the present paper, who is Professor of Botany and Horticulture in the Illinois Industrial University, has prepared it with the object of presenting, in language as far as possible freed from technical terms, the principal and most interesting facts now known about these active agents. He also gives references to other sources of information on the subject.

THE Q. P. INDEX ANNUAL FOR 1882. Bangor, Me.: Q. P. Index. Pp. 51.

A VALUABLE, useful, and convenient publication. It contains a list of all the articles that appeared during the year in twenty-three different American and foreign publications, indicated by a notation simple and easily learned, so that, while reference is easy, the whole is compressed into a very small space.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Inundations in Louisiana: Their Influence on Health. By Stanford E. Chaillé, A. M., M. D. New Orleans. Pp. 27.

Eleventh Cincinnati Industrial Exhibition: Rules and Premium List. Cincinnati: Davis & Heineman. Pp. 76, with Plans.

Contributions to the History of Lake Bonneville. By C. K. Gilbert. Washington: Government Printing-Office. Pp. 32, with Two Maps.

The Yellowstone National Park: Manual for Tourists. By Henry J. Winser. New York: G. P. Putnam's Sons. Pp. 96, with Map. 40 cents.

Didactics in the State University of Iowa. By S. N. Fellows, Iowa City, Iowa. Pp. 24.

Cranial Nerves. By W. O. Thrailkill, San Francisco, Cal. Chart. One page. 56 cents.

Old Maryland Manors. By John Johnson, A. B. Baltimore: Johns Hopkins University. Pp. 38. 30 cents.

John Howard Payne Souvenir: Portrait and Autograph. Boston: L. Prang & Co. Pp. 4.

A Recent Find in the Trenton Gravels. By C. C. Abbott, M. D. Trenton, N. J. Pp. 10.

Reports of the Trustees of the Sanitary Improvement Bonds of the City of Jacksonville, Fla. Pp. 118.

Address of Vice-President A. H. Tuttle, Section of Histology and Microscopy, American Association. Salem, Mass.: Salem Press. Pp. 14.

How to make Photographs. New York: E. & H. T. Anthony & Co. Pp. 91, with Plates.

Handbook of Medical Electricity. By A. M. Rosebrugh, M. D. Toronto, Ont.: Dudley & Burns. Pp. 54.

Planting Trees in School-Grounds. Washington, D. C.: United States Bureau of Education. Pp. 8.

Normal Condition of Cellular Structure and Peach Yellows. By D. P. Penhallow (Houghton Farm Experiment Department). Mountainville, N. Y. Pp. 45, with Three Plates.

Zoölogical Society of Philadelphia, Eleventh Annual Report. Pp. 26.

Industrial Art in Schools. By Charles G. Leland. Washington, D. C.: United States Bureau of Education. Pp. 37.

The Impress of Nationalities upon the City of New York. By James W. Gerard. New York: Columbia Spectator Publishing Company. Pp. 32.

The Citizens' Law and Order League of the United States, Proceedings, etc. Chicago: Cowles & Dunkley. Pp. 81.

Worcester Free Institute, Statement. Worcester, Mass. Pp. 16.

Worcester Free Institute, Statistical Information. Worcester, Mass. Pp. 16.

Variations of Barometric Measurements of Altitude with the Season. By John Tatlock, Jr. Pp. 20.

The Library Journal, March-April, 1883. New York: F. Leypoldt. Pp. 68. $4 a year.

United States Bureau of Education: Its Work and History. By Charles Warren, M. D. Washington: Government Printing-Office. Pp. 29.

Clinical History and Localization of Perinephric Abscesses. By John B. Roberts, M. D., of Philadelphia. Pp. 19.

Heart-Puncture and Heart-Suture as Therapeutic Procedures. By John B. Roberts, M. D., of Philadelphia. Pp. 5.

Preliminary Report on the Venoms of Serpents. By S. Weir Mitchell, M. D., and Edward T. Reichert, M. D., of Philadelphia. Pp. 14.

Bulletin of the Buffalo Naturalists' Field Club, No. 3. Buffalo, N. Y.: Hicks & Beach. Pp. 24.

The Biographer. Illustrated. New York: 23 Park Row. Monthly. Pp. 64. 25 cents each number.

Bulletin of the Philosophical Society of Washington. Vol. IV, pp. 189; Vol. V, pp. 189.

Notes on Copper Implements from Mexico. By F. W. Putnam. Cambridge, Mass. Pp. 12.

The Philippine Islands. By Samuel Kneeland, M. D. New York. Pp. 28.

The Magazine of American History. With Notes and Queries. April, 1883. New York: A. S. Barnes & Co. Pp. 80, with Map.

On the Conservation of Solar Energy. By C. William Siemens, F. R. S., D. C. L. London: Macmillan & Co. Pp. 111. $1.75.

Deep Breathing. By Sophia Marquise A. Ciccolina. New York: M. L. Holbrook & Co. Pp. 48.

A Visit to Ceylon. By Ernst Haeckel. Translated by Clara Bell. Boston: S. E. Cassino & Co. Pp. 337. $2.50.

A Book about Roses. By S. Reynolds Hale. New York: William S. Gottsberger. Pp. 326.

Golden Sands: A Collection of Little Counsels for the Sanctification and Happiness of Daily Life. Translated from the French. New York: G. P. Putnam's Sons. Pp. 101. $1.50.

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POPULAR MISCELLANY.

Higher Professional Aims.—"The Higher Professional Life" was the subject of Dr. J. M. Da Costa's recent valedictory address to the graduating class of Jefferson Medical College, Philadelphia. The higher aim of the physician should be to add to knowledge and increase the resources of his profession. It may be sought in various ways: by making original inquiries in the way that Darwin and Pasteur have so brightly illuminated; by cultivating literary tastes, and thereby becoming quicker in perception and more skillful in disseminating truths once learned; by mixing in the great movements that are to benefit mankind, and becoming influential in them; and by becoming active for the advancement of sanitative and preventive medicine. "There are thus many ways in which the aspirations of a higher professional life may be realized in useful or in great work. Some of these can be followed only when success has brought comparative leisure; but all can be kept in mind; one or all can be aimed at throughout our careers, and according to our individual strength."

The Glacial Moraine in Pennsylvania.—We have already mentioned the fact that Professor H. Carvill Lewis has traced the great glacial terminal moraine along its whole course through Pennsylvania. An account of his investigations is given in a paper recently read by him before the Franklin Institute of Philadelphia. The moraine enters the State in Northampton County, at latitude 40° 49′, and may be followed in a northwesterly direction till it enters New York from Potter County, at a height of 2,580 feet. It afterward turns at right angles to its former course, and, trending to the southwest, re-enters Pennsylvania at Pine Grove township, Warren County, whence it may be traced till it crosses the State line into Ohio at Darlington township, Beaver County, latitude 40° 50′. It thus leaves Pennsylvania at almost precisely the latitude at which it entered it; and, if a straight line were drawn across the State between these two points, the line of the moraine would form with it a right-angled triangle, whose apex would be a hundred miles distant from its base. The moraine crosses the Delaware at an elevation of 250 feet, the Allegheny River at an elevation of 1,425 feet, and the Beaver at an elevation of 800 feet above the sea, or 225 feet above Lake Erie. Upon the highlands it rises a thousand feet or more higher. The distinction between the glaciated portion of the State and the region south of glacial action is very marked, and the moraine itself is so sharply defined that at one point, Buck Mountain in Luzerne County, Professor Lewis was able to stand with one foot upon the glaciated and the other upon the non-glaciated region. The moraine is very finely developed west of Bangor, in Northumberland County, where it forms a series of "hummocky" hills one or two hundred feet high. Its course in Monroe County, as it winds from the top of the Kittatinny Mountain down to Cherry Valley, and then up again on to the Pocono, is a complete vindication of the glacial hypothesis. It is in no sense a water-level, nor could it have been formed by floating ice or by any other cause than that of a great glacier. It is wonderfully shown upon the summit of Pocono Mountain, over 2,000 feet above the sea, where a great ridge of moraine hills, twelve miles long, one mile wide, and 100 feet or more high, composed of unstratified till, and bearing numerous bowlders of Adirondack gneisses and granites, rises out of the plateau. The "kames" of Cherry Valley, with their accompanying "kettle-holes," and the terraces near Stroudsburg are also interesting features. Immense as was the power of the slowly moving glacier, says Professor Lewis, "it had but slight effect upon the topography of the country. It is a mistake to suppose that glaciers can level down mountains or scoop out cañons. The glacier had merely 'sand-papered' the surface of the rocks."

Joseph Duncan Putnam.—Joseph Duncan Putnam, late President of the Davenport (Iowa) Academy of Natural Sciences, who died December 10, 1881, had accomplished a remarkable amount of scientific work during his short life of twenty-seven years. He was born in Jacksonville, Illinois, in 1855; began making a collection of insects when eleven years old, and at-

tempted their scientific classification in his fourteenth year. At the same time he was interested in other branches of science and collections. In 1872 he spent three months in the mountains of Colorado with Dr. C. C. Parry; in 1873, five months as meteorologist to Captain Jones's Yellowstone expedition. The next year he spent chiefly in Colorado, completing a series of expeditions in which he collected altogether 25,000 specimens of insects, many of them very rare. From 1869 he was one of the most active and useful members of the Davenport Academy, and was in succession its recording secretary, corresponding secretary, and president; and he sustained a large share of the burden of the editorial supervision and publication of its "Proceedings." Mr. Putnam's scientific publications were not voluminous. With one or two exceptions his most important investigations were never fully elaborated, and were embodied only in notes, letters, and incomplete manuscripts. A list of twenty-one is given, of which the most valuable are papers on bark-lice, and on his investigations of the *Salpugidæ*, a group intermediate between the scorpions and the spiders. A paper by him on "Insects and Flowers of Colorado" was published in the tenth volume of "The Popular Science Monthly."

Getting Water in the Desert.—The supply of water always formed a principal question, and often a preponderant one, during the marches of the French troops in Algeria and Tunis. Rivers having a permanent supply of water are very rare in those countries, but *wadies*—beds of torrents, generally dry, but full after a shower—are numerous. The most ordinary supplies of water were *sedirs*, or puddles of rain-water held in natural basins of clay or stone, near which the camps were pitched whenever they were accessible. They are to be found in the beds of wadies, and sometimes in slight depressions of the plain, where they are frequently of considerable extent. When full they contain, notwithstanding they are so shallow, prodigious quantities of water, which is, however, exposed to an enormous evaporation, so that it does not last long. These natural reservoirs have been covered with sand in many places, where a permeable bed several feet high has been formed, with a dry surface corresponding with the general level of the surrounding land. It is only necessary to dig a hole, and wait a little while, for the water to rise to a certain level, forming a kind of extemporaneous well, which the Arabs call an *oglat*. These wells contain but little water, and are soon dried up when drawn from, but will become filled again in the course of a few hours. These resources, precarious at the best, are often wanting; but the country is full of ruins, attesting the former existence of a large population, and among them are many useful structures, including well-made cisterns still almost entire, and very deep. Water is got from them by going down steps to the surface, or by means of a device called the *guerber*, which is in general use. This is a leathern bottle, adjusted at the curb of the well by means of pulleys and ropes, which are worked in such a manner by a man and an ox that the vessel goes up and down, fills itself with water and empties itself, without any one having to handle it directly.

Symptomatic Anthrax and Disinfectants.—The Lyons "Médicale" publishes the results of some valuable experiments which have been made by MM. Arloing, Cornevin, and Thomas, on the influence of various disinfecting agents on the virus of symptomatic anthrax. If the contents of a tumor in this disease be allowed to dry slowly at a temperature of 35° Cent. (or 95° Fahr.), a residue is obtained in which the organisms of anthrax retain their full activity. Water, through which a little of the residue is diffused, has a virulence not inferior to that possessed by the fresh virus, and which continues for at least two years. It was found, in carrying on the experiments, that the resisting power of the dried virus is much greater than that of the fresh. Whatever destroys the dried is capable of destroying also the fresh virus, while the converse is not true. The following substances were found to have no effect even upon the fresh virus: alcohol saturated with camphor or carbolic acid, glycerine, ammonia, acetate and sulphate of ammonia and sulphate of ammonium, benzine, a saturated solution of chloride of sodium, quicklime and lime-water,

polysulphide of calcium, a one-in-five solution of chloride of manganese, a one-in-five solution of sulphate of iron, a one-in-five solution of borate of soda, a one-in-five solution of tannic acid, a one-in-ten solution of sulphate of quinine, a one-half solution of hyposulphite of soda, essence of turpentine, and monobromide of camphor; of gases, ammonia, sulphurous acid, and chloroform. A saturated solution of oxalic acid, a one-in-twenty solution of permanganate of potash, a one-in-five solution of soda, vapor of chlorine, and sulphide of carbon, destroyed the fresh virus, but had no effect on that which had been dried, while the activity of the latter was destroyed only by solutions of carbolic acid (two per cent), salicylic acid (1 in 1,000), nitrate of silver (1 in 1,000), sulphate of copper (1 in 5), boric acid (1 in 5), saturated salicylic alcohol, corrosive sublimate (1 in 5,000), and bromine vapor. Thus many substances, unanimously regarded as antiseptic, were without effect upon the virus, even in the fresh state. This is the case with pure and camphorated alcohol, with which surgeons are accustomed to wash their instruments, quicklime, with which dead bodies are consumed, etc.

The Poisons in Tobacco-Smoke.—Herr Kissling, of Bremen, has published a useful paper on the poisonous constituents of tobacco-smoke, among which he specifies as strong in quality, carbonic oxide, sulphureted hydrogen, prussic acid, picoline bases, and nicotine. The first three substances, however, occur in such small proportions, and their volatility is so great, that their share in the action of tobacco-smoke on the system may be neglected. The picoline bases, too, are present in comparatively small quantity; so that the poisonous character of the smoke may be almost exclusively attributed to the large proportion of nicotine present. Only a small part of the nicotine in a cigar is destroyed by the process of smoking, and a relatively large proportion passes off with the smoke. The proportion of nicotine in the smoke depends, of course, essentially on the kind of tobacco; but the relative amount of nicotine which passes from a cigar into smoke depends chiefly on how far the cigar has been smoked, as the nicotine-content of the unsmoked part of a cigar is in inverse ratio to the size of this part—that is, more nicotine the shorter the part. Evidently, in a burning cigar, the slowly advancing zone of glow drives before it the distillable matters, so that in the yet unburned portion a constant accumulation of them takes place. More, relatively, of this substance passes into smoke in the case of cigars that are poor in nicotine than in the case of cigars with much of that substance. Nicotine, notwithstanding its high boiling-point, has remarkable volatility.

Fisheries of New York.—According to the reports of the Census Bureau, New York is fourth in the list of fish-producing States, the value of its products being $4,380,565, but it holds a still more prominent position in several special branches. Its menhaden-fisheries are more extensive than those of any other State, its yield of the products of that branch being more than half that of the whole country. The value of its oyster-products, $1,577,050, is greater than that of any of the other States, except Maryland, Virginia, and New Jersey. It returns the largest quantities of clams, both hard and soft; and it ranks third in respect to the shad-fisheries. Seven thousand two hundred and sixty-six of its inhabitants, and $2,629,585 of capital are engaged in the fishing industries.

Liquid Air and Solid Alcohol.—M. Cailletet, a French chemist, some time ago succeeded, by liquefying ethyline and causing it to boil, in producing a temperature of −105° C. (−157° Fahr.), at which he liquefied a few gases under strong pressure, and even caused oxygen to approach the liquid state. M. Wroblewski, of Cracow, one of his pupils, continuing the experiments, has, by boiling liquid ethyline in a vacuum, produced a temperature of −136° C. (212½° Fahr.), at which sulphuret of carbon and alcohol were congealed, and oxygen and nitrogen became liquid. The change in the form of oxygen was obtained on the 9th of April in three experiments in which the conditions of pressure (22½ to 26½ atmospheres) and temperature were slightly but not essentially varied. Liquid oxygen is transparent and colorless, differing in this from ozone, which

is deep blue. Liquid nitrogen has a similar appearance. Sulphuret of carbon is a white solid at —116° C., but becomes liquid when raised to —110° C. At —130° C., alcohol assumes the form of a white solid, which becomes viscous at —129°. Carbonic oxide was liquefied under similar conditions with nitrogen.

Ancient Cities in Guatemala.—Mr. A. P. Maudslay, at one of the recent meetings of the London Geographical Society, described some ruined cities in Guatemala which he had visited during parts of the winters of 1881 and 1882. At Quirigua, not a very great distance from Livingstone, the Atlantic port of the country, the ruins consist of raised terraces or mounds, usually faced with stone, and elaborately carved monoliths, representing human and animal figures, situated near them. The upright monoliths measure from three to five feet across the sides, stand from twelve to twenty-five feet out of the ground, and bear human figures, of which the heads are sculptured in high relief, and are usually surmounted by grotesque masks, whence spring elaborately carved head-dresses. The body and dress are covered with the most intricate and elaborate ornament, in which small human faces and grotesque forms frequently occur. Of the animal-shaped stones, some had curved claws and indications of armor like that of an armadillo, and held a human head, apparently the head of a woman, between their jaws. The largest of these stones, which was estimated to weigh about eighteen tons, represented a turtle, whose head was replaced by a huge grotesque human head, while in place of its tail was a life-sized figure of a woman sitting cross-legged, and holding in her hand a manikin scepter somewhat resembling the children's toy of a monkey on a stick. The whole surface of the stone was covered with a profusion of ornaments. All of the monuments bore hieroglyphics and carved tablets—probably symbolical—of curious character. At Tikal, in the extreme northern part of the state, all the houses were made of stone, and coated with plaster, with walls about three feet thick, and the roofs built in the form of gables, without any attempt at an arch. The most imposing buildings are the five temples raised on almost pyramidal foundations. Beams of sapota-wood were used in supporting the building, and many of them remain in various states of preservation, while all were elaborately carved. The ruins of Usumacinta, on the river of the same name, and on the border of the Mexican State of Chiapas, were visited for the first time. The houses are more spacious than those at Tikal, and the lintel-beams are of stone, and handsomely carved. One of the houses, which is described as a typical specimen, is built on a succession of terraces; the first terrace, seventy-three feet long by seventeen feet broad, has three doorways, each with a rather poorly carved stone lintel, and is finished off with a projecting cornice. Above it is a second course of eleven feet of stone-work, and over this is a hollow superstructure, looking like a pigeon-house with numerous pigeon-holes. The entire height of the building is about forty-two feet. The whole house has been covered with stucco, and painted in various colors. On the second story are three large and eight small panels, which once held human figures molded in plaster; and in the center of the "pigeon-hole" course is another panel, which once contained a figure of more than twice the size of life. Only parts of these figures now remain, but enough to indicate what they were. Inside the house is a great stone idol, twice the size of life, well carved and sitting cross-legged, with its hands on its knees, like the figures of Buddha; the remains of a canopy of ornamental plaster-work were found near it. Remains of circular stone altars were found in different parts of the ruins, and earthen pots, partly filled with some half-burned resinous substance. The Lacandone Indians, who live here, speak the Maya dialect of Yucatan, and were observed to be lighter colored than Mr. Maudslay's Indian workmen, and to have thick lips, a prominent nose, and an extraordinary receding forehead, nearly resembling the foreheads represented on the carved stones. Their only weapons, so far as Mr. Maudslay could see, were stone-tipped arrows. Their communities were often at war with each other, generally on account of the efforts of one or the other to carry off women. The pots of half-burned incense found

in the ruins and near the idol, some of which were comparatively fresh, are supposed to have been made and brought by them; and the suggestion is offered that it is the fact of these Indians still holding in reverence the temples built by their ancestors and offering incense in them that has led to the current Central American belief in the existence of one of the ancient cities still existing hidden somewhere in the forest. The mythic city has been gradually driven farther back, and this river, the Usumacinta, now marks about the last place where it could be looked for.

Lightning-Rods.—A committee, representing several societies interested in the subject, which was appointed some time ago to inquire into the best method of constructing and adjusting lightning-rods, has recently made a most valuable report, based upon all the information it was possible to procure. Inasmuch as sharp points, even if made of platinum, are liable to be melted and blunted, the report recommends that the rod should preserve its full diameter nearly to the extremity, and be merely beveled off. To preserve the sharp points for drawing off the silent discharges of electricity, the attachment of a copper ring, bearing three or four needles of suitable size, at a distance of about a foot below the extreme top of the rod, is suggested. Vanes, finials, and other ornamental ironwork on the upper part of a building, must be metallically connected with the conductor. A coronal, consisting of a copper band, with stout copper points, each a foot long, at intervals of two or three feet on its circumference, is recommended for the chimneys of factories. Copper is preferred to iron as the material for rods, chiefly because it is less liable to be injured and rendered inefficient by rust. The diameter should be three eighths of an inch for copper rods, half an inch for copper rope, and nine tenths of an inch for iron rods. The rods should not be insulated from the building, but should be attached to it by fastenings of the same metal as the rod itself. A good earth-connection is specially important. In towns, connection with the iron water and gas mains is recommended, but not with lead pipes, because they are too liable to be melted. As a general rule, the lower end of the conductor should be soldered to a plate of the same metal as itself, having an area of not less than a square yard, while the hole in which this plate is sunk must be so deep that the earth surrounding the plate shall be moist even in the driest weather. Drains and water-courses may be utilized for keeping the plate in connection with a large extent of moist earth. It is recommended that the height of the rod be such that a cone having its vertex at the upper terminal, and its sides sloping at forty-five degrees, shall inclose the whole building, or as much of it as this particular rod is required to protect.

Too Long School-Sessions.—A governmental commission in Alsace-Lorraine for the investigation of the sanitary conditions of school-life has made a report in which, besides noticing the unfavorable conditions that usually receive attention in such documents, stress is laid upon the fact that the principles of mental education have not partaken during late years of the progressive improvement which has characterized most branches of knowledge. Thus, the greater variety in the instruction which is imparted by modern education fails in many cases to accomplish its purpose, and is of advantage only to pupils of more than average capacity. Much evil is believed to arise from school-children remaining too long in a cramped or otherwise restrained position, and from the excessive and premature strain to which the youthful brain is often subjected, while the dangers of moral and physical infection are always present. Improvements in the ventilation and sanitary arrangements of schools, however important in themselves, are, it is urged, of comparatively little use, when the pupil is kept for too long a time every day in a combined state of bodily inactivity and mental tension.

Schools and Infectious Diseases.—The question is sometimes presented whether it is expedient to close a school, among some of the pupils of which infectious diseases have appeared. The fact that the conditions and customs of school associations give facilities for the dissemination of contagion which are quite unknown in any other phase

of social life often makes it seem that the closing of the school is indispensable to the checking of the disease. The necessity of such an extreme measure may, however, be nearly always prevented by the exercise of proper foresight. The teacher should be watchful of absences and their causes, and should give notice, when infectious disease is in question, to the proper officers. The sick pupil should then be isolated from the well ones, and his home and family surrounded with the most rigorous sanitary precautions for not less than eight weeks. Dr. David Page, sanitary officer of Westmoreland, England, has always avoided the necessity of extreme measures by adhering to these principles. The school should be closed only when it has obviously become a starting-point of infection, or when the control specified above can not be exercised. The term of suspension must be determined by circumstances, and can not be previously regulated, but a premature reopening should be avoided; and the reopening should be preceded by a thorough disinfection, by fumigation with sulphur and washing the walls with lime and the wood-work with soap and carbolic acid. The continuance of day-schools during the prevalence of scarlatina is justified, says Dr. Page, when the children would be otherwise exposed to much risk in playing about their doors with children of infected families, and with those barely recovered from illness. Under such circumstances, always provided that due supervision over infected families is maintained, a child runs less risk in regular attendance at school. But in scattered country districts, where the children coming from all points are brought together only during school-hours, the breaking up of the school is the best and safest course.

Earth-Tremors.—The committee appointed by the British Association, two or three years ago, to measure the lunar disturbance of gravity, have met with unexpected difficulties in the accomplishment of their task, and have substantially given it up as for the present unattainable. The Messrs. Darwin, who undertook the observations at Cambridge, found that, as soon as they had made their instrument sensitive enough to record the lunar disturbances, they had to deal with other disturbances, "so incessant and so lawless that the steady march of the lunar swing was utterly overborne and lost." The earth was never really still. It quivered and throbbed and warped and bent under the pendulum night and day, and even, as it seemed, in the absence of all merely local agencies that could be detected." A situation at the bottom of a deep mine was then suggested, but with no better success. The earth yields there under the operation of deep-reaching causes that can not be got rid of, and which produce effects of the same order of magnitude as the direct effect of the moon, and are at present inextricably entangled with it. These causes are the varying mass of the air, that shifts and changes according to the indications of the barometer, and the varying mass of the water on the shores, that shifts and changes with the tides. It is easy enough to believe that, when a mountain-mass is set down upon the earth, the crust must yield and a depression form at the spot upon which the excess of weight is placed. "But it was probably never imagined till now that, when the barometer rises an inch over a land area like that of Australia, the increased load of air sinks the entire continent two or three inches below the normal level. Over a like sea area the water surface may be depressed a foot or more. Thus, as the mass of air sweeps in wind or creeps by slower convection from place to place, the yielding earth sways up and down beneath its weight"; a depression is formed, toward the center of which the surface slopes from all sides, and the plumb-line ceases to be perpendicular to the surface. The mass of air which hovers over the spot also acts like a mountain and draws the pendulum toward it; the two effects are superimposed, and the apparent displacement of the vertical is exaggerated. The two influences always act together, and are proportional; and this twofold deviation is of the same order as that which the moon produces, but is perpetually varying and incalculable. It therefore vitiates all pendulum observations. The tides exercise a similar power, depressing the shore at the flood and allowing it to rise at the ebb. The advance and retreat of the water will also tell on the plummet by mere attraction. The lead will seem to be pulled

seaward at high water, and will swing back landward at the ebb. At sixty miles away from the Atlantic coast the deflection due to tidal action of this kind is probably quite as great as the greatest deflection due directly to the moon. These flexures are not confined to the surface, but must extend in almost equal degree beyond the depth of the deepest mine. Until the atmospheric pressure and the state of the tides at each moment can be accurately known for a great distance around any given spot, the experimental determination of the lunar disturbance of gravity is out of our reach; our instrument, even in the most favorable site, must needs record incessant variations of which no satisfactory account can be given. A gravitational observatory must, therefore, for the present content itself with registering the more or less irregular tremors of the earth that are allied with earthquake-movements.

English and Metric Measures.—The following comparative summary of English and French (or metric) standards of measures and weights will be useful: The English inch is equivalent to 2·54 centimetres; the foot to 30·48 centimetres; the yard, to 94·44 centimetres; the mile to 1609·33 metres; the nautical mile, to 1852·30 metres.

The square inch is equivalent to 6·45 square centimetres; the square foot, to 929·01 square centimetres; the square yard, to 8364·13 square centimetres.

The cubic inch is equivalent to 16·387 cubic centimetres; the cubic foot, to 28·516 cubic decimetres; the cubic yard, to 764·535 cubic decimetres; the pint, to 0·567 cubic decimetre; the gallon, to 45·410 cubic decimetres.

The English grain is equivalent to 64·799 milligrammes; the ounce avoirdupois, to 28·349 grammes; the pound, to 453·590 grammes; the ton, to 1016·050 kilogrammes.

The foot-pound is equivalent to 0·13825 kilogrammetre; the French horse-power, to 75 kilogrammetres a second; and the English horse-power (550 foot-pounds a second, or 33,000 foot-pounds a minute), to 76 kilogrammetres a second.

The metrical unit of pressure is the kilogramme per square centimetre. We may also count by centimetres of mercury or by atmospheres. A pressure of one atmosphere corresponds to a column of mercury 76 centimetres high, or to 1·033 kilogramme per square centimetre. The English pound per square inch corresponds with 70·3 grammes per square centimetre.

False Fangs in Harmless Snakes.—The blowing-viper or puffing-adder of the United States, although it is timid and unaggressive, and can rarely be provoked to bite, and then does no particular harm, has been reputed a dangerous and venomous reptile because it has long, fang-like posterior teeth. It belongs to the genus *Heterodon*, which is so called on account of this unusual and irregular dentition. It is of the same group as the *Xenodons*, or strange-tooths, of tropical America, which are also supposed there to be poisonous, possibly for no better reason than our North American genera are. Dr. Stradling allowed one to bite him, and suffered no ill effects from the wound. Mrs. Catharine C. Hopley states, in "Land and Water," that she has lately examined one of these strange-toothed snakes for the purpose of seeing the fangs, when she observed that they are mobile, or what are called in the viperine snakes hinged teeth—that is, they are so set that the snake can erect or depress them at pleasure by a volitional movement of the jaw. It is known, she says, that no poison-gland exists in this snake, "and it was only on venturing to feel the teeth, in order to judge of their relative sizes, that the reptile let me know it had a larger pair safely tucked away in case I took too many liberties."

NOTES.

A STEP toward fixing a system of uniform standards of time was made by the convention of railroad managers which was held at St. Louis, April 11th. Hour-lines were agreed upon at fifteen degrees of longitude apart, to which the clocks in the districts respectively appertaining to them shall be made to conform. Four standards were made: Eastern time, to agree with that of the 75th meridian; central time, one hour slower, to be regulated by the 90th meridian; and two other standards, two and three hours slower than Eastern time, to be fixed by the 105th and 120th meridians. All changes in time will be made at the termini of roads or at the ends of divisions.

THE Cockeville Iron and Steel Company at Seraing, Belgium, employing about ten thousand workmen of all kinds, maintains free night-schools, which are attended by about two thousand boys and adults from the works; an industrial or technical school, which is attended by about eighty fitters and boiler-makers, and by the clever young men in all the departments; and a mining-school, with two hundred students. In the steel department all the young men under eighteen are required to attend the night-school, and those who willfully absent themselves are liable to expulsion. At the great zinc-works near Liége, also, the apprentices are required to attend evening-schools.

THE Davenport (Iowa) Academy of Sciences has recently received from the Rev. J. Gass a number of the peculiar "curved-base" mound-builders' pipes. One of them is a finely carved stag's head, representing the antlers bent around the bowl, in relief; another is an eagle, perched and holding some small animal in its claws; two others are neatly carved birds; another is a finely sculptured black bear; a sixth is supposed to represent a fox, with the face turned backward; a seventh is a nondescript animal. Others are plain. The bear is cut from a black stone; the other pipes are in ash-colored pipestone or red catlinite.

UP to the present date, we understand, there have been received in answer to the official letter of inquiry to the members of the British Association, as to whether they intended to go to Montreal or not, replies in the affirmative from three hundred and forty. Among these are a good many who may be said to be really representative of English science, but, as might be expected, the younger men are present in a larger proportion than the older.—*Nature.*

PIERRE CARBONNIER, the distinguished French pisciculturist, has recently died. He was the author of several monographs on the natural history and cultivation of fishes, and contributed many papers to scientific journals. He was also director of the Aquarium of the Trocadéro at the French Exhibition of 1878.

MR. W. S. BARNARD, of the Department of Agriculture, observes that ants may do valuable service as destroyers of larvæ and insects, particularly of the cotton-worm, which appears to be fiercely attacked by all the species. Even the smallest ant all alone will assault and worry the worm, and the insects appear plentiful in all the fields. They dispatch the younger worms very quickly, but the older ones more often escape. Ants are, however, detrimental, though indirectly, to vegetation, in that they protect aphides or plant-lice by keeping off the insects that would prey upon them. This they do for the sake of the honey-dew which the lice excrete while sucking the juices of the plants on which they live. It may be noticed that plants suffer most from aphides where ants are most numerous.

THE agricultural interests of the south of France have been nearly ruined by the substitution of the artificial alizarine for madder in dyeing, the silk-worm disease, and the phylloxera. The cultivation of madder will have to be given up, for it can not again be made profitable. The disasters wrought by the silk-worm disease and the phylloxera, now that remedies have been discovered, may be repaired in time. To expedite the recovery of the depressed agriculture, an extensive scheme of irrigation has been arranged, by which water will be drawn from the river Rhône in canals, and distributed to all the country within reach.

MR. GEORGE SUTTON, of Aurora, Indiana, traces the causes of the floods in the Western rivers to the great aërial currents which bring on extensive storms independently of local influences, now in the Missouri, now in the Mississippi, now in the Ohio Valley, in summer or winter as the storms may occur. Whenever four inches of water fall suddenly over the seventy-seven thousand square miles of the Ohio Valley, a rise of sixty-three feet will be produced in the river at Cincinnati; and if the ground be deeply frozen and heavily covered with snow, the flood will be much higher. What the people of the river valleys need to enable them to avoid disaster from floods is to know beforehand the height to which the water will rise, and this may be determined by ascertaining how much rain is falling. The Signal-Service Office could provide this information by systematically collecting and publishing measurements of the rain-fall at points in all parts of the water-sheds of the large rivers.

AN Association of American Naturalists was organized at Springfield, Massachusetts, in April last, of which Professor A. Hyatt was chosen president, Professors H. N. Martin and A. S. Packard, Jr., vice-presidents, and Professor S. F. Clarke, of Williams College, secretary. Twenty-seven members were enrolled. The Association adopted the name of the "Society of Naturalists of the Eastern United States."

A NOTEWORTHY feature of the recent third annual meeting of the German Geographical Society, at Frankfort, was the presence, as the hero of the occasion, of the youthful African explorer, Lieutenant Wissmann, and by his side Dr. Rüppell, now eighty-nine years old, who explored Egypt and Nubia seventy years ago, and Abyssinia and the other Red Sea countries twenty years later.

PHILIPP REIS.

From a Photograph by T. H. Voigt.